Franklin Transportation & Street Technical Standards

City of Franklin, Tennessee
Engineering Department

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Department of Engineering
7/3/07

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CHAPTER

I

GENERAL PROVISIONS AND REQUIREMENTS

1.1 - Purpose

This document describes transportation design requirements that present a comprehensive approach to designing new and modified streets within the City of Franklin (hereinafter referred to as “City”). These requirements will provide better streets throughout the City, reflecting best practices and providing more capacity with safe and comfortable travel for motorists, pedestrians, bicyclists, and transit riders.

Franklin’s historic streets have long symbolized our City’s beauty and quality of life. However, many streets have also come to symbolize the growing pains that can accompany growth and prosperity, with increased congestion in some portions of the City. Therefore, these street design guidelines have been developed in response to three basic issues:

- The City needs to plan for continued growth and development.
- The people that reside in the City want quality streets with good traffic flow.
- The City recognizes the connection between land use and street design.

1.2 Applicability

These specifications shall apply to any person, developer, firm, business, or entity interested in and desiring to construct additional streets, to extend existing streets, or to do any construction; such as curb cuts, that may affect the public streets within the City. These specifications are intended to apply only to new streets within new development areas and generally shall not apply to existing streets, unless remedial work such as widening or rehabilitation of the existing streets is required. Excavations and cuts to existing streets and rights-of-way shall be governed by Chapter 2 of Title 16 of the Franklin Municipal Code (“FMC”), but may require compliance with these regulations only if the City Engineer deems it necessary and appropriate, given the work requested. Design of streets, structures and associated elements such as traffic signals, signing, and lighting shall be sensitive to the character of the surrounding area and the impacts on historic resources.

By adhering to the principles set forth in this document, negative impact from growth and development will be reduced, preserving the community’s quality of life, health, safety and welfare.

1.2.1 – Traditional and Conventional Area Specifications

The City has Traditional and Conventional Areas as defined in the Zoning Ordinance. The design requirements provided in Chapter 3 of this document apply to new developments or redevelopment work in Conventional Areas only. Design requirements for Traditional Neighborhood Developments are presented in Chapter 4 and are applicable only to new streets within these defined developments.

Street designs for Traditional Areas other than TND shall incorporate an awareness and sensitivity to the character of the existing development areas such as downtown and the surrounding neighborhoods.

1.3 - Jurisdiction / Regulations

Except as may otherwise be required by law, these rules and regulations govern the construction of streets and all associated improvements and appurtenances that shall be installed within the street system of the City of Franklin, Williamson County, Tennessee, and shall apply to all areas within the jurisdiction of the City.

1.4 - Specifications and Resources

This document is the result of cooperation of many departments within the City. For a complete list of reference material, refer to the Appendix listings. The following publications will be referred to in these specifications.

- “A Policy on Geometric Design of Highways and Streets”, American Association of State Highway and Transportation Officials; AASHTO.

- “Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)” American Association of State Highway and Transportation Officials; AASHTO

- “Guide for the Development of Bicycle Facilities”, American Association of State Highway and Transportation Officials; AASHTO.

- “Guidelines for Urban Major Street Design, a Recommended Practice”, Institute of Transportation Engineers; ITE.

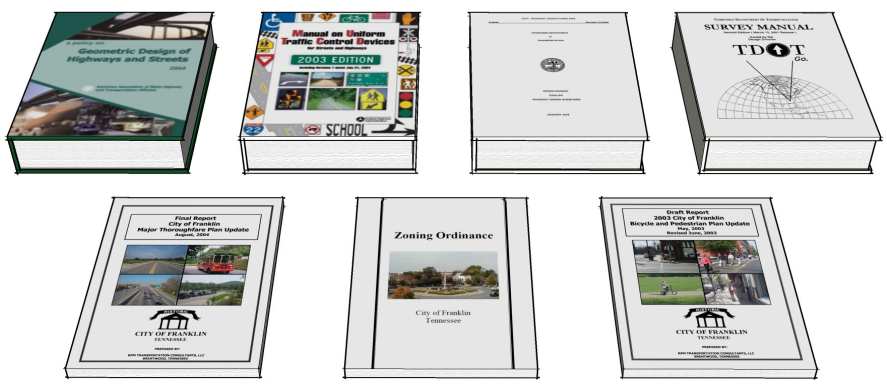
- “Manual on Uniform Traffic Control Devices for Streets and Highways”, (MUTCD) U.S. Department of Transportation, Federal Highway Administration; FHWA.

- The Tennessee Department of Transportation; TDOT, “Standard Specifications for Road and Bridge Construction”, latest edition, technical specifications only, shall apply and be adhered to unless superseded by these specifications.

- “North Carolina State Building Code, Volume 1-C Accessibility Code”, latest edition, North Carolina Building Code Council.

- The Tennessee Department of Transportation; Survey Manual issued by the Design Division; TDOT.

- The City of Franklin’s Corridor and Connector Streets Economic Development Projects; Zoning Ordinance; Stormwater Ordinance; Subdivision Regulations; 1998 Major Thoroughfare Plan Update (1998 MPTU) latest edition; Land Use Plan, Administrative Manual, and the Bicycle and Pedestrian Plan Update (BPPU) – latest edition.



In the event of a conflict between this document and the aforementioned referenced specifications, the specifications contained in this document shall govern.

1.5 - Plan Review Procedure / Fees

After receiving approval of the Preliminary Plat, Final Plat, Regulating Plan, and/or Site Plan, the Developer or Developer’s Engineer shall submit construction drawings for approval.

1.5.1 **Letter of Transmittal with Fees.** A letter of transmittal (an example can be found in the Appendix) along with the construction drawings and specifications (Plans) and a check for the Plan Review Fee (current fees can be found on the Infrastructure Fee Worksheet in the Appendix) shall be submitted to the City Engineer.

1.5.2 **Drawings: Requirements.** The Plan submittal shall consist of neat, scaled drawings with specifications and any other pertinent supportive data as required for review approval in at least four (4) copies, two (2) of which will be retained by the City with the remainder to be returned to the Developer or his Engineer. These drawings shall include all aspects of the street, grading and drainage, including documentation or supporting evidence that proves sufficient engineering calculations have been performed in accordance with the approved project. The construction drawings and drainage calculations shall bear the stamp of a Registered Tennessee Professional Engineer. Other submittals for approval which are necessary and to be done by the Developer may include, but are not limited to the Franklin Planning Commission; the Tennessee Department of Transportation, the Tennessee Department of Environment and Conservation, and the Tennessee Division of Water Pollution Control, Natural Resources Section.

1.5.3 **Approval of Drawings and Fees, On-site approved drawings required.** The City Engineer must approve plans, calculations and fees prior to the start of any work on the project. A complete set of approved Plans shall be available at the construction site at all times. Plans will not be deemed approved until the City Engineer and Street Department's stamps of approval have been affixed to the cover sheet of the drawings and specifications.

1.5.4 **Expiration of construction drawings.** Approval of construction drawings shall be valid for one (1) year from the date of approval. If construction has not begun within this time, the Plans shall be resubmitted as stated above for approval.

1.6 - Permits

Prior to beginning any construction, the Developer and/or Contractor, shall obtain all necessary permits as required by law. Such permits may include, but are not limited to, those required by State of Tennessee, Williamson County and other City of Franklin agencies.

The Developer shall obtain a "Grading Permit", “Stormwater Management Permit” and “Tree Cutting Permit” (where necessary) from the City prior to beginning any construction activities. The “Grading Permit” is issued by the City Engineer upon presentation of proof of required approvals of drawings and specifications and upon payment of required fees.

Once the grading and drainage plans are approved, the developer/contractor must complete steps identified in the City’s approved forms prior to receiving a grading permit. Approved forms for permits can be downloaded from the official City website: www.franklin-gov.com/engineering or they can be printed from the Appendix of this specification. Contact the City Engineer’s Office if you require further information, for example about detailed planning, other current regulations and guidelines or possible historic and cultural aspects.

1.7 - Notification of Construction

In addition to any other notices required by law (e.g., TN One Call, notices to non-participating utilities), before commencing any street construction operations, a 24-hour notice must be given during regular business hours to the City Engineer’s office. This advance notice is required for all street construction projects to ensure proper inspection staff scheduling. Demolition permits, if required for the project, shall be obtained from the Codes Department.

1.8 - Quality Control Testing

Construction materials, including aggregate base stone, asphalt, concrete, and roadway sub-grades shall be fully tested in accordance with the designations and requirements within the referenced “TDOT Standard Specifications” sections. Unless otherwise noted within the “Standard Specifications” section, the type and number of tests called for by the referenced standards shall be performed.

Testing shall be done by an independent testing laboratory whose qualifications are approved by the City. Testing results will be submitted to and approved by the City Engineer. The City reserves the right to require industry standard certifications of testing and inspections by the testing laboratory, mills, shops and factories. Such certifications required shall be submitted in duplicate.

The Developer shall provide the necessary labor and supervision required to support field testing by the independent testing firm and inspections by City officials at no cost to the City. Test reports of field testing if applicable shall be submitted directly to the City Engineer. Defects disclosed by tests shall be rectified at no cost to the City. The Developer is required to have the design engineer or a certified quality control inspector present during all phases of construction. A daily log of work performed should be kept by this individual.

1.9 - Inspection

All projects shall be subject to inspection during and upon completion of construction by an authorized representative(s) of the Engineering Department. Presence or absence of an inspector during construction does not relieve the Developer and/or Contractor from adherence to approved plans and material contained in these specifications or from liability. Materials and/or workmanship found not meeting requirements of approved plans and specifications shall be immediately brought into conformity with said plans and specifications.

An authorized representative of the Engineering Department shall make a final inspection of the project after completion to determine acceptability of the work and for release of performance bonds if required. Before this final inspection can be made, the Engineer responsible for the project shall certify in writing to the City Engineer that the work has been completed in accordance with approved plans and specifications.

The cost for inspection during construction is covered by the “Grading Permit” fee. Additional inspection fees will be required only when an inspection requiring City approval fails and requires subsequent re-inspections. The Inspection Fee (current prices can be found on the fee schedule in the Appendix) shall be paid to the Engineering Department before issuance of the "Grading Permit".

Drainage facilities including, but not limited to, culverts, detention basins and ditches, as well as the roadway sub-grade, base stone and binder & surface coarse shall be inspected, tested and given approval at each stage of installation prior to proceeding to the next stage of construction. Final construction inspection for approval and acceptance of streets and drainage systems will not be granted until all work has been completed in accordance with the approved plans.

1.10 - Acceptance of Facilities

After construction has been completed, a final inspection will take place by the Street Department Director and the City Engineer. A Certificate of Acceptance will be issued once all contractual agreements have been met and construction meets the extents considered satisfactory under these specifications and deemed as such by the Street Department Director and the City Engineer.

Acceptance of Facilities will only be issued after As-Built plans that adhere to requirements listed in Chapter 2 have been submitted and approved by the City Engineer.

In the event of requests for acceptance of streets meeting development build-out requirements, but fronting a remaining vacant building lot, the developer shall post a Lot Bond for the vacant lot to insure protection of the as-built street improvements. Such bonds shall meet the requirements of Franklin Municipal Code §12-106, regarding Lot Bonds.

1.11 - Modifications

Occasions may arise where the minimum standards are either inappropriate or cannot be justified economically. Modifications from the standards in this manual will be considered by the City Engineer on a case-by-case basis using the following criteria:

1) Whether the modification requested complies with acceptable engineering standards;
2) Whether the modification requested does not present a danger to the general health, safety or welfare to the traveling public or pedestrians; and
3) Whether the modification is necessary and meets or exceeds the standard using acceptable alternative design or methods.

If the special district, developer, contractor, or utility responsible to the City for public improvements desires to design and construct such improvements in modification to these standards, such modification(s) should be identified in a written attachment to the initial submittal of plans. A request for modification shall be denied if the following information is not provided:

1) Identification of the standard provision to be modified.
2) Identification of the alternative design or construction standards proposed.
3) A thorough justification of the modification request including impact on short- and long-term capital and maintenance requirements and cost.
4) Request shall be prepared and sealed by a professional civil engineer licensed to practice in the State of Tennessee.

1.12 - Revisions to these Specifications

These specifications will be adopted by ordinance of the City Board of Mayor and Alderman and shall be revised by ordinance; however, forms and administrative procedure are subject to change as deemed necessary by the City Engineer with thirty (30) days' notice from posting on the City's website or advertising in a publication of general circulation within Williamson County.

CHAPTER 2

PLAN STANDARDS

2.1 - General

In order to provide consistency and maintain accuracies, the following criteria are to be adopted for the roadway plans.

Plans submitted must be submitted in the form of CAD generated original drawings. Each plan submittal should include (4) full scale plan sets on matte bond paper as well as a CD containing all CAD files associated with the plan set. CAD files should be AutoCAD compatible. If you have the means to produce PDFs (portable document format) of your plan set, they are a welcomed addition to the CD.

Exemptions to these standards may be granted by the City Engineer upon request, based on project scope and location.

2.2 – Survey

Survey information in the form of point data files must be included on a CD at the time of plan submission. All survey data gathering should adhere to the TDOT Survey Manual.

Survey procedures require that all surveys shall be tied to the State Plane Coordinate System using the Tennessee Geodetic Reference Network (TGRN). All surveyed coordinate values will be based on the North American Datum 1983 (NAD/83) (1995 adjustment) coordinates and appropriate notes indicating such shall appear on the topography plot.

All design computations shall be based on these adjusted coordinate values. This will ensure that all computed points on the project will have coordinate values tied to the State Plane System. Assumed coordinates will not be used.

Coordinate values for all PI's shall be shown on present and proposed (if any are shown) layout sheets within each curve data table. Coordinate values shall also be listed for the beginning and ending points of the project. A notation near the title block in lower right hand corner for each sheet on which coordinates appear shall read, *"Coordinates are NAD/83 (1995), are datum adjusted by the factor of 1.000XXX"* and tied to the TGRN. The "1995" refers to the year of the most recent adjustment of coordinate values in Tennessee and 1.000XXX refers to the actual datum adjustment factor used for the project.

2.3 - Preparation

The following sub-sections contain specific information on sheet preparation.

2.3.1 - Dimensions and Directions

All units of measurement shall be in English standard units of feet. Distances shown on the plans shall be no more accurate than the nearest .01 foot (35 ft, 35.0 ft, and 35.00 ft, are acceptable; 35.001 ft is not acceptable).

Bearings shown on the plans shall be no more accurate than 1 second (for example N 35 00' 01" E is acceptable; N 35 00' 01.1" E is not acceptable). P. I. coordinates shall be computed to three decimal places, and then bearings recomputed to even seconds. Bearings and the beginning coordinate point are then held constant and P.I.'s and ending coordinates recomputed to three decimal places.

Coordinates of P.I.'s and G.P.S. control points shall be shown to an accuracy of 0.001 foot. Any other coordinates shall be shown to an accuracy of 0.01 foot.

2.3.2 - Scale and Sheet Size

Use the following table for general guidelines on scale as it relates to the type of plans you are submitting. These are general guidelines and exceptions to these scales may be approved by the Engineering Department. *Preferred* scales are in italics.

	~ 50' Project Length		~ 250' Project Length		~ 1000' Project Length		> 1 Mile Project Length	
Scale:	1" = 5'	*1" = 10'*	1" = 10'	*1" = 20'*	1" = 30'	*1" = 50'*	*1" = 50'*	w/ Match Lines
Sheet Size:	11" x 17"	8.5" x 11"	36" x 24"		36" x 24"		36" x 24"	

NOTE: Each sheet shall have a left-hand margin of one and one-half inch (1 ½”) for binding.

2.3.3 - Drafting Specifications

Font Size: Text on plans shall consist of entirely vertical capital letters. Minimum recommended text size shall be equivalent to Leroy 120 Guide or 1/8" text height. If lack of space dictates, limited amounts of text equivalent to Leroy 100 Guide may be accepted at the discretion of the City Engineer. Plan sheets with text smaller than Leroy 100 Guide will not be accepted.

Title Block: Each submitted drawing for City projects shall have a standard City border and title block in the lower right-hand corner of the drawing. The title block shall include a space for revisions and dates. Electronic copies of the border and title block may be downloaded from the Engineering Department downloads webpage. An example of the City title block is included in the Appendix.

Endorsement: All submitted final plan sets shall be signed and sealed by a Tennessee registered professional engineer. Each sheet within the plan set shall be signed and sealed with the exception of any standard drawing provided by the City or TDOT. The engineer of record will be held responsible for information contained within the plan set.

2.4 - Construction Plan Submittal

Plans should be 100% complete at this stage. The project must meet requirements as they relate to appropriate public road approaches, required taper distances for pavement transitions, grades, vertical stopping sight distance, and intersection sight distance.

As a general guideline, the *supporting calculations should include any engineering information that is pertinent to the project*. These may include, but are not limited to the following:

- Drainage calculations including culvert and bridge analysis, drainage areas, runoff values, energy dissipators
- Intersection sight distance calculations
- Quantity calculations (City projects)
- Structural calculations

The designer is encouraged to add notes on the plans explaining special situations or items which are not readily apparent and that would influence the proposed design. The following sheets and information will be reviewed for quality assurance at this submission:

Title Sheet – At this stage of the project, information on the title sheet should include the following:

- Project numbers
- Project location map including north arrow and scale
- Description of project work type
- Reference points at the beginning and end of the project

- Project lengths, including incidental construction
- Design data including design speed, design criteria, functional classification, terrain, traffic data, etc.
- Signature block

Index and General Notes Sheet – Provide a list of utility owners and addresses that will be affected by the project. The index blocks should be completed to indicate the sheet numbers for the plans.

Typical Cross Sections – These should only show basic configuration and design features. This will typically include the following:

- Lane and shoulder widths tied to centerline
- Construction centerline
- Profile Grade Line
- Cross slopes
- Pavement Design
- Station ranges/limits
- Curbs
- Sidewalk locations and widths
- Bicycle facilities
- Side slopes
- Shoulder configurations if warranted
- Retaining walls, culverts, and bridges if warranted
- Ditches, Seed/Sod areas

Plat Sheet/Property Map – (if required) should be included for projects that require acquisition of right-of-way.

Plan and Profile Sheets - Elevations and grades of special ditches should be shown so that accurate right-of-way requirements can be determined. Typically, the plan view and profile should be shown on the same sheet. In addition to the criteria required for the previous submittal, the plan and profile sheets should include the following:

- Horizontal alignment (e.g., horizontal curve data, PC, PI, PT, bearings)
- Vertical alignment and its relationship to grade controlling features
- All alignment controlling features (e.g., high-water levels, existing cross roads and bridges, regulated drains, drainage structures, railroads, under drain criteria, traffic maintenance considerations, cemeteries, historical buildings, parks, ADA requirements, etc.)
- Preliminary drainage details, e.g., bridges and mainline culverts.
- Project limits
- Drainage features (e.g. pipe structures, ditch grades, preliminary inlet spacing for storm-sewer trunk line designs, etc.) and proposed drainage notes
- Public road approach and drive locations
- Construction limits
- Proposed right-of-way
- Approximate roadside barrier locations
- Permanent erosion protection
- Index and general notes sheet should be up-to-date and accurate.
- The plan and profile sheets should reflect correct structure notations, sodding, rip-rap and paved sodded ditch locations should be indicated; earthwork balances are shown for City projects; and removal items are noted.

- If the project is to be funded by the City, tabulated values should be included in the plan sheets that show quantities of all needed items.
- North Arrow and Scale for each sheet

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Cross Sections – The cross sections should include the following:

- Profile grade line
- Templates of the typical section placed on the existing cross sections
- Drainage structures
- Approaches and drives
- Clearance to buildings
- Final structure notation and final earthwork areas and volumes

Detail Sheets – The proposed layouts should be included as follows:

- Turning movements and turn lanes
- Pavement markings
- Signals
- Signs, including sign structures
- Lighting
- Retaining walls
- Special drainage structures
- Superelevation transition diagrams
- Plans for temporary erosion control, traffic maintenance details, and traffic design elements (e.g., intersections, signals, signing and lighting).

Traffic Maintenance Details – The proposed traffic maintenance scheme and phasing should be outlined and may be accompanied with TDOT Standard Drawings

Structure/Drainage Data Table – The preliminary information to be included in the structure data table is as follows:

- Location
- Size
- Type
- Approximate elevations and grades where necessary for clarity
- Type of headwall

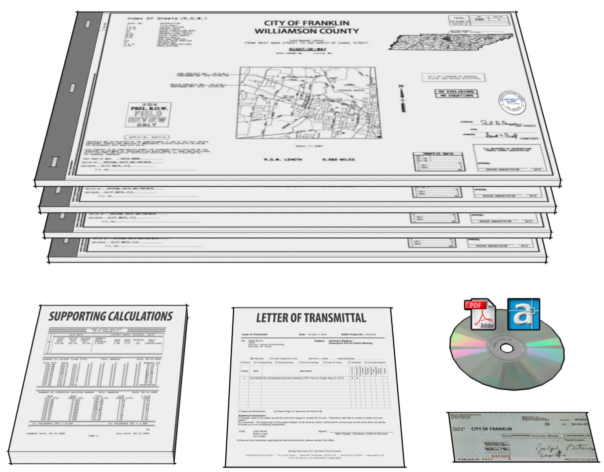
Design Information - In addition to the plans, the designer should include copies of the hydraulic analysis for mainline culverts and bridges, if applicable, and results of any economic analysis that may have been completed for alternative grade lines.

Cost Estimate – A construction cost estimate is required for City funded projects only. Quantities for all major items should be included in the cost estimate. Miscellaneous pay items previously accounted for as a percentage of the cost estimate and which are not required to complete tables in the plans do not need to be quantified.

2.5 - Checklist for Plan Submittal

The following represents the minimum required for construction drawing submittal to the City Engineer's office. *The following items must meet the requirements set forth in Section 2.4 of these specifications prior to plan submittal.*

- ☐ Letter of Transmittal – this will include the date of submittal, contact information, project information, and a checklist of submitted items.
- ☐ (4) Bound Copies of CAD generated, full-size plan sheets which have been *endorsed by a TN registered professional engineer*
- ☐ Supporting engineering calculations *endorsed by a TN registered professional engineer*
- ☐ CD-Rom containing all CAD files associated with the project, survey information, and preferably PDFs of plan sheets / supporting calculations
- ☐ A check for plan review made out to "The City of Franklin". (current prices can be found on the fee schedule in the Appendix)



NOTE: Additional items may be requested by the City Engineer's office.

2.6 - Revision of Plans

Should, prior to, or during construction, necessary changes be anticipated that would in the opinion of the Street Department Director constitute significant revision of the plans already approved by the City, said plans shall be revised with said changes shown and resubmitted as required in Section 1.4, "Plan Review Procedure", along with a letter stating why such changes are believed necessary. Changes deemed to be minor in nature by the Street Department Director may be made during construction with the changes noted for inclusion in the "as-built" drawings to be submitted to the City prior to final acceptance.

The City Engineer shall have the right to re-review the entire set of Plans should a revision of the plans be required.

2.7 - As-Built Plan Submittal

Final as-built plans should be submitted immediately following completion of construction activities. If the project is developed in phases, as-built plans for each phase shall be submitted once the work is complete in that phase. Acceptance of Facilities will not be issued until satisfactory as-built plans have been approved by the Street Department Director and the City Engineer.

All aspects of the project that have been affected by construction should be verified and appear on the as-built plans. This would include, but is not limited to the following items:

- All property lines and easements
- Existing structures (Include patio covers, decks, trellises, sheds, pools, fences, poles, etc…)
- Location of all "as-built" work with station and offsets
- Height and location of all fences, walls, screens, tress and hedges over 42" tall
- All commercial driveways, paved areas, and required parking spaces
- All concealed components with station and offsets (include known buried cables, utilities, drainage structures, etc…)
- Video documentation of storm drainage (if required).

Concealed components will require documented proof to be submitted with the as-built plans in the form of a certified construction log that has been generated by the design engineer or a certified quality control inspector as detailed in Section 1.7 of these specifications.

As-built plans are required to be *endorsed by a Tennessee registered professional engineer and or a registered land surveyor.*

CHAPTER 3

STREET DESIGN

Appendix

3.1 Standards for Design

The purpose of this chapter is to present the City criteria and guidelines for the design of conventional streets and other related elements in the street right-of-way. It is to be used by the City, developers and their engineers in the design of public and private streets for which approval by the City Engineer is required. This chapter is not intended to address streets in areas designated as "traditional neighborhood development (TND)" areas, streets in the downtown urban core of the City, or streets in designated historic districts (**Chapter 4** addresses street design for traditional neighborhoods). However, certain criteria and guidelines in this chapter may be determined to be applicable to streets in these areas in order to preserve the public health, safety and welfare, as determined by the City Engineer.

3.1.1 General

All design drawings and support data submitted to the City Engineer for approval must be sealed by a registered Professional Engineer, licensed to practice in the State of Tennessee.

The design criteria, as presented, are intended to aid in preparation of plans and specifications, and include minimum standards where applicable. These design criteria are considered minimum and a complete design will usually require more than is presented in this document. Design of streets shall follow the TDOT *Roadway Design Guidelines* (latest edition) unless otherwise noted in these specifications. For items not addressed in the TDOT guidelines, the AASHTO *"A Policy on Geometric Design of Highways and Streets"* (hereinafter referred to as the "*Green Book*", latest edition) and other relevant AASHTO design documents should be consulted for guidance. Where conflicts exist or interpretations are required, the City Engineer shall make the final determination in consultation with the designer.

3.1.2 Location and Layout of New Streets

The location and layout of new streets shall be as identified in the Major Thoroughfare Plan, Subdivision Regulations and Zoning Ordinance. Streets not identified in the Major Thoroughfare Plan shall meet the needs of the specific development and satisfy all other specific requirements of this chapter. The City Engineer retains the authority to designate collector and arterial streets as needed for circulation and emergency access and retains authority for approval of the overall street layout.

All streets shall have a logical relationship to the existing topography and to the location of existing, platted or planned streets within adjacent properties. In instances where a proposed street is not indicated on the Major Thoroughfare Plan, it should support a rectangular grid or modified grid street network to the maximum extent practicable. Curvilinear street networks should only be used when topographic or environmental constraints make use of the grid pattern undesirable, or when established development patterns on adjacent lands make the grid pattern infeasible.

The street layout for all subdivisions should be designed to ensure connectivity, enhance general circulation and to provide secondary points for emergency access. They shall also provide safe, efficient, and convenient vehicular, bicycle, and pedestrian access within and between developments. Certain streets may need to be extended to property boundaries to provide for the future logical extension of the street through adjacent properties. If an arterial or collector street is located within or adjacent to a development, the development shall continue the street to a logical termination point as determined by the City Engineer.

A major component in street layout is neighborhood traffic safety. This is an essential transportation issue in the City. Streets should be designed to limit excessive traffic speeds and volumes in neighborhoods and provide for safe travel for all modes of transportation including pedestrian, bicycle, and vehicles. In addition, new streets in neighborhoods shall be laid out to minimize opportunities for cut-through traffic.

3.1.3 Circulation Plan Required

All new development and redevelopment in the City shall prepare a Circulation Plan. The Circulation Plan shall address street connectivity, emergency and service vehicle access, parking movements, accommodation of loading operations, and similar issues. The City Engineer may waive the requirement for a Circulation Plan on a case-by-case basis in the event that, in his opinion, a new development has no anticipated impact upon circulation, or proposes no change in existing circulation patterns. See **Section 5.10.3** of the **Zoning Ordinance** for more information on requirements for Circulation Plans.

As a part of the required Circulation Plan, the City Engineer may require, at no cost to the city, a Traffic Impact Analysis (TIA) to be prepared in accordance with the standards contained in **Section 5.10.3** of the **Zoning Ordinance**.

3.1.4 Connectivity

Circulation Plans shall achieve internal street connectivity by providing multiple connections to the existing city street network wherever possible. Whenever cul-de-sac streets are created, at least one eight-foot-wide pedestrian access easement shall be provided, to the maximum extent practicable, between each cul-de-sac head or street turnaround and the sidewalk system of the closest adjacent street or pedestrian sidewalk or pathway (see Water and Sewer Specifications for requirements if this easement also includes utilities). In addition to the internal street connectivity, Circulation Plans shall maintain external street connectivity in accordance with the standards set forth in **Section 5.10.4** of the **Zoning Ordinance**. To encourage shared access points on public streets, Circulation Plans prepared for all new attached residential, nonresidential, and mixed-use development shall also facilitate cross access between adjacent land uses.

3.1.5 Traffic Control Devices

All signs, markings, signals and other traffic control devices used on streets in the City shall be designed, installed and used in conformance with the State of Tennessee edition of the *Manual on Uniform Traffic Control Devices* (MUTCD), as adopted by ordinance into the City Municipal Code.

Traffic signals have significant impact on the efficiency and safety of the City's major street system. It is therefore essential that the impact of any new signal request be thoroughly evaluated before its approval, design and installation. This evaluation shall initially include a warrant analysis in conformance with the MUTCD. If a traffic signal meets one or more warrants, an operations analysis shall be performed to determine the initial and future impact of that signal on overall corridor operations performance, including both efficiency and safety factors.

Chapter 9 of this document provides additional information on traffic signals.

Chapter 11 of this document provides additional information on traffic signs and markings.

3.1.6 Private Streets

Private streets serving more than one lot shall be built to the same standards as required for public streets.

3.1.7 Applicability

In the event of conflict or overlap with the street design requirements in this document and the requirements in the latest edition of the *Subdivision Regulations*, *Zoning Ordinance*, *Major Thoroughfare Plan*, or *Bicycle and Pedestrian Plan*, the standards and specifications in this document shall control.

3.2 Street Classification and Right-of-Way

3.2.1 General

Listed below are the classifications of public streets used in the City. These classifications primarily provide different levels of emphasis in regard to traffic movement versus direct access to property. Transportation improvements developed in accordance with the street classification system will help to discourage through traffic from using local neighborhood streets, and local traffic from congesting regional travel facilities. This will not only improve the efficiency of the transportation system in the City, but will also maintain the livability of its neighborhoods.

The City *Major Thoroughfare Plan* specifically identifies all streets classified as Freeways, Expressways, Arterials and Collectors in the City. Streets without one of these classifications shall normally be considered a Local street. However, the City Engineer shall have the authority to verify all street classifications for the purpose of applying street design standards.

3.2.2 Street Classifications

(1) Freeways and Expressways
Such streets are used to handle high traffic speeds and volumes. These street classifications emphasize traffic movement while restricting private access to adjacent land. All freeways and expressways in the City are anticipated to be owned and designed by the Tennessee Department of Transportation (TDOT).

Typical Expressway

(2) Arterial Streets
Arterial streets are intended to primarily serve moderate to high traffic speeds and volumes within and through the City. Arterial streets may provide some access to abutting property, but only as it is incidental to the primary functional responsibility of travel service for major traffic movements. Arterial streets are classified as either Major Arterials or Minor Arterials depending upon expected traffic usage and adjoining property access.

Typical Arterial Street

(3) Collector Streets
Collector streets are intended to primarily serve slow to moderate traffic speeds and volumes and to distribute traffic from the arterials throughout the City to other collectors, arterials and local streets. Collector streets should provide both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas. Collector streets will be classified as either Major Collectors (further broken down to commercial/industrial or residential), or Minor Collectors depending upon expected traffic usage and adjoining property access. Major Collector streets may have limited driveway access to maintain the street's ability to achieve a safer and efficient traffic flow.

Typical Collector Street

(4) Local Streets
Local streets are intended to primarily serve slow speeds and volumes and to provide access to abutting lands and connections to the higher street classifications. Local streets are to be planned so that future urban expansion will not require the conversion of local streets to collector or arterial streets. Local streets may be commercial/industrial or residential depending upon the type and extent of the development and zoning they serve. Local streets may be terminated by a “cul-de-sac” where necessary due to topographic or other constraints.

Typical Divided Local Street

(5) Alleys

Alleys are intended to primarily serve very slow speeds and volumes associated with the rear access and service functions for residential and commercial properties. Residential alleys shall be limited to a typical cross-sectional width of sixteen (16) feet within a twenty (20) foot right-of-way. “T-shaped” alleys, where one alley terminates into another alley, shall be prohibited unless designed as directed by the City Engineer when special circumstances exist. No vehicle parking area, fence, structure, vegetation, or wall shall be erected, maintained, or planted within the alley right-of-way or within two feet of the edge of the alley’s pavement/curb, whichever is greater.

Typical Alley

(6) Private Streets

Private streets are streets that provide access to more than one lot but are not owned, operated and maintained by the City. Private streets shall be required to meet City design standards as determined by the City Engineer.

(7) Frontage Roads

Frontage roads are streets that normally run parallel to major roadways, usually arterials, to provide access to adjacent properties. Such streets greatly reduce the level of private driveway access to the major streets. Frontage roads are not typically used in the City and must be approved in advance by the City Engineer.

3.2.3 Cross Sections

Typical features and dimensions of standard City streets are illustrated in the street typical cross section standard drawings found at the end of this chapter. These standard sections may be revised by the City Engineer on a case-by-case basis, to meet specific needs that may exist, or are projected to exist, along a particular street section. The following table summarizes for each standard section the primary design elements and their dimensions.

Table 3.2.3 Street Typical Cross Section Elements by Classification

STD DWG #	Street Classification	Right-of-Way	Travel Lanes	Median	Bike Lanes	Sidewalks	Multi-Use Path	Parking Lane
TS-1	Major Arterial	135’	Four @ 12’	40’	Two @ 6’	Two @ 6’	No	No
TS-2	Major Arterial	130’	Four @ 12’	40’	No	One @ 6’	One @ 12’	No
TS-3	Minor Arterial	120’	Four @ 12’	24’	Two @ 6’	Two @ 5’	No	No
TS-4	Minor Arterial	115’	Four @ 12’	24’	No	One @ 5’	One @ 12’	No
TS-5	Major Collector	115’	Four @ 12’	24’	Two @ 4’	Two @ 5’	No	No
TS-6	Major Collector	115’	Four @ 12’	24’	No	One @ 5’	One @ 12’	No
TS-7	Minor Collector	80’	Two @ 12’	No	Two @ 4’	Two @ 5’	No	Two @ 8’
TS-8	Minor Collector	70’	Two @ 12’	No	Two @ 4’	Two @ 5’	No	One @ 8’
TS-9	Minor Collector	65’	Two @ 12’	No	Two @ 4’	Two @ 5’	No	No
TS-10	Minor Collector Boulevard	90’	Two @ 13’	28’	No	Two @ 5’	No	No
TS-11	Commercial Local	55’	Two @ 12’	No	No	Two @ 5’	No	No
TS-12	Residential Collector/Local	50’	Two @ 11’	No	No	Two @ 5’	No	No
TS-13	Alley	20’	One @ 16’	No	No	No	No	No

3.2.4 Right-of-Way and Easements

(1) Right-of-Way
Minimum right-of-way widths shall be as shown in **Table 3.2.3** and in the street classification typical cross section drawings at the end of this chapter. Topography, special design features and other factors may require widths greater than these minimums. The City Engineer shall have final review with determination of any additional right-of-way that is required for the design of a specific street segment.

(2) Easements
There are several types of street-related easements allowed in the City. The first type is a Public Utility and Drainage Easement (PUDE) that shall be approved for use by the City Engineer on a case-by-case basis. The second type is a Temporary Construction Easement (TCE) that may be used to provide adequate construction area in the construction of a street project. A third type is a Slope Easement (SE) that provides for slopes between the street right-of-way and adjacent property. A fourth type is an Access Easement (AE) that allows multiple users of an access to the street. A fifth type is a Permanent Drainage Easement (PDE) for drainage purposes only.

(3) Improvements in Right-of-Way
It is the policy of the City to place all permanent public streets and street-related features in public street right-of-way, with fee simple ownership by the City.

(4) Additional Right-of-Way Widths on Existing Streets
Developments that adjoin existing streets shall dedicate additional fee simple right-of-way, where necessary, to meet the minimum requirements for the functional street classification of the existing street, or other dimensions as required by the City Engineer. This dedication shall be as follows:

> **(a)** The entire right-of-way shall be provided where any part of the development is on both sides of the existing street.
>
> **(b)** When the development is located on only one side of the existing street, one half (1/2) of the required width of the right-of-way, measured from the center line of the existing roadway, shall be provided. If the development provides improvements to the existing roadway that shifts the centerline of the roadway, then the one half (1/2) of the required width of the right-of-way shall be measured from the new center line of the roadway.

(5) Dedication Process
The dedication of right-of-way and easements for street purposes shall normally occur through the platting process. When dedications are required outside the platting process, they shall be dedicated in a manner and format approved by the City Engineer and City Attorney.

3.3 Design Criteria

The design criteria presented in this section apply to all roadways that are required to be designed and constructed to City standards and specifications. The design criteria presented below should be used as minimum requirements for new developments and may be increased at the direction of the City Engineer if warranted by safety hazards or traffic operations.

The City Engineer, in consultation with other City departments and State agencies, may allow modifications to the design criteria set forth in this chapter. Modifications may be necessary to allow private or public construction to be compatible with in-place improvements or to address unusual circumstances that justify an alternative design or criteria. Modifications to design criteria may be allowed provided that an investigation by the City Engineer concludes that all of the following criteria can be satisfied.

- The modification to the design criteria is based on sound engineering principles and practices.
- The modification to the design criteria will not create an unsafe or hazardous situation to occur.
- The modification to the design criteria will be equivalent to the minimum criteria set forth herein in terms of functionality, efficiency, durability, structural integrity and long term maintenance.
- The modification to the design criteria will not adversely impact adjacent properties or individual property owners, provided that safety is not compromised.

The City Engineer is authorized to require studies or other pertinent information to be provided by the petitioner to help support or validate the modification request at no cost to the City. See **Chapter 1, Section 10**, for additional information on the variance process.

All streets are to be designed in accordance with the design speeds specified for each street classification in this chapter, or as amended by the City Engineer, and as summarized in **Tables 3.3A and 3.3B**.

3.3.1 Desired Operating Levels of Service

It is the policy of the City to design street segments and intersections to operate at a Level of Service "C" or better during the routine peak traffic loading conditions of the system. Lanes used for turning movements within intersections shall maintain at least a LOS "D". Should these levels of service not be achievable due to verifiable constraints, the City Engineer shall have final approval on the street design requirements necessary to attain the optimal operating and safety conditions available given the specific circumstances of a street or intersection location. See **Section 5.10.3** of the **Zoning Ordinance** for more information on level of service.

3.3.2 Design Traffic Level

Streets shall generally be designed to accommodate projected future traffic conditions a minimum of twenty (20) years (or another target year agreed to in the Traffic Impact Analysis Memorandum of Understanding (MOU)) after the street is opened to traffic. These projected traffic conditions shall address total daily traffic loads along with directional distribution of the peak-hour loads. These loads shall address typical weekday conditions as well as off-peaks and weekend periods when applicable. Seasonal and special event conditions shall also be considered where appropriate as determined by the City Engineer.

3.3.3 Design Vehicle

All streets shall be designed to accommodate the predominant type and composition of vehicles that can be reasonably expected to travel through them. At a minimum, for streets and intersections designed in the City, the vehicle types in **Table 3.3.3** shall be fully accommodated in the design process. For special circumstances other design vehicles may be required by the City Engineer.

TABLE 3.3A STREET STANDARDS – GENERAL PARAMETERS[a]

Design Feature or Characteristic	Street Classification and Typical Section											
	4-Lane Major Arterial **TS-1**	4-Lane Major Arterial **TS-2**	4-Lane Minor Arterial **TS-3**	4-Lane Minor Arterial **TS-4**	4-Lane Major Collector **TS-5**	4-Lane Major Collector **TS-6**	2-Lane Minor Collector **TS-7**	2-Lane Minor Collector **TS-8**	2-Lane Minor Collector **TS-9**	2-Lane Minor Collector Blvd **TS-10**	2-Lane Commercial Local **TS-11**	2-Lane Residential Collector/Local **TS-12**
Right of Way (ROW) Width	135	130	120	115	115	115	80	70	65	90	55	50
No. of Travel Lanes	4	4	4	4	4	4	2	2	2	2	2	2
Travel Lane Width	12	12	12	12	12	12	12	12	12	13	12	11
Travel Lane Width (total)	48	48	48	48	48	48	24	24	24	26	24	22
Median Width	40	40	24	24	24	24	n/a	n/a	n/a	28	n/a	n/a
Curb & Gutter: Vertical or Mountable	V[b]	V[b]	V	V	V	V	V	V	V	V	V	V/M
Designated Bike Lanes?	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No
Bike Lane Width per side	6	n/a	6	n/a	4	n/a	4	4	4	n/a	n/a	n/a
Parking Lane Width	n/a	n/a	n/a	n/a	n/a	n/a	8 (2 sides)	8 (1 side)	n/a	n/a	n/a	n/a
Minimum Sidewalk Width	6	6 (1 side)	5	5 (1 side)	5	5 (1 side)	5	5	5	5	5	5
Multi-Use Path	No	12 (1 side)	No	12 (1 side)	No	12 (1 side)	No	No	No	No	No	No
Grass Strip Width	6	6	6	6	6	6	6	6	6	6	5	5
Minimum Roadside Width	13.5	12.5	13	13	12.5	13	13.5	12.5	14	13	11.5	11.5
Left Turn Lanes Req'd?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Left Turn Lane Width	12	12	12	12	12	12	11	11	11	11	11	11
Right Turn Lanes Req'd?	Yes	Yes	Yes	Yes	Maybe	Maybe	Maybe	Maybe	No	No	No	No
Right Turn Lane Width	12	12	12	12	12	12	12	12	12	11	11	No
Traffic Volume Capacity (1000 veh/day)	>35	>35	25-35	20-25	15-20	15-20	10-15	10-15	5-10	5-10	2-5	<1
Speed Limit, MPH	45	45	40	40	35	35	30	30	30	30	25	25
Driveway & Street Access	Very Ltd	Very Ltd	Limited	Limited	Limited	Limited	Frequent	Frequent	Frequent	Frequent	Frequent	Unlimited
Continuity of Travel	Very High	Very High	High	High	Moderate	Moderate	Moderate	Low	Low	Low	Very Low	Very Low
Street Lights	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Partial	Partial	Partial	Partial
Traffic Calming	None	None	None	None	None	None	None	None	Possible	Possible	Possible	Possible

NOTES: a. All dimensions in feet.
b. Vertical curb requires should separation from travel lane on design speeds of 50 mph or greater.

TABLE 3.3B STREET STANDARDS – TECHNICAL DESIGN CRITERIA[a,b]								
Design Element		**Arterial**		**Collector**		**Local**		**Alley**
		Major	**Minor**	**Major**	**Minor**	**Comm/Industrial**	**Residential**	
Overall Design Parameters								
Design Speed/Posted Speed		50 / 40-45	45 / 35-40	40 / 30-35	35 / 25-30	30 / 25	30 / 25	20 / 15
Stopping Sight Distance		425	360	305	250	200	200	115
Passing Sight Distance		1,835	1,625	1,470	1,280	n/a	n/a	n/a
Horizontal Alignment[e]								
Minimum centerline radius: with no super-elevation		1,039	1,039	762	510	330	330	107
with 0.02 super-elevation		794	794	593	n/a	n/a	n/a	n/a
with 0.04 super-elevation		711	711	533	n/a	n/a	n/a	n/a
Maximum super-elevation		0.04 ft/ft	0.04 ft/ft	0.04 ft/ft	n/a	n/a	n/a	n/a
Minimum tangent between curves or at intersections		200	150	150	100	100	75	50
Vertical Alignment								
Maximum Centerline Grade %		6	7	8[c]	10	8	14[d]	8
Minimum Gutter Flow-line Grade %		0.5	0.5	0.5	0.5	0.5	0.5-1.0	1.0
Minimum K-values for Vertical Curves	Crest	84	61	44	29	19	19	7
	Sag	96	79	64	49	37	37	17
Intersection Design								
Minimum sight distance at driveways and intersections (street and topographic features may increase these minimums)		550	475	400	325	250	250	100
Access Management								
Distance Between Intersections	Signalized	2,640		1,320	1,320	n/a	n/a	n/a
	Unsignalized	1,200	600	300	300	200	200	n/a
Minimum distance between high volume driveways/alleys & street intersections		660	420	300	200	150	150	n/a
Minimum distance between driveway edges		250	250	150	150	100	50	10
Minimum comer clearance between driveway edges & street intersections		300	300	275	275	175	50	40
Driveway width (two-way)		25 - 36	25 - 36	25 - 36	25 - 36	25 - 36	10 - 20	n/a
Driveway approach street configuration		Radius Return	Radius Return	Radius Return	Radius Return	Radius Return	Curb Cut	Radius Return

NOTE: a. All dimensions in feet.

b. These dimensions may be increased or amended by the City Engineer as deemed necessary for safe and efficient street operations.

c. The maximum centerline grade is 10% on residential major collector streets.

d. Maximum desirable grade is 10% unless existing conditions justify the use of a higher grade. When a higher grade is proposed, it must be approved by the City Engineer to ensure ease of service for emergency and service vehicles.

e. Values based on low speed (45 mph or less) urban street guidance from 2004 AASHTO Green Book.

Table 3.3.3 Design Vehicle Requirements	
Street Classification	Vehicles Accommodated
Alley	Passenger cars and single-unit trucks.
Local	Passenger cars, single-unit trucks (SU-30), and conventional school buses must be able to turn easily from one street to the next and remain in the correct lane for each street. Combination trucks (WB-50) shall be able to physically traverse local streets by using the full width of the traveled way if necessary, including intersection turns, and without tracking onto the curb at corners.
Minor Collector	Passenger cars, single-unit trucks and conventional school buses must be able to turn easily from one street to the next and remain in the correct lane for each street. Combination trucks (WB-50) shall be able to physically traverse the street by using the full width of the traveled way if necessary, including intersection turns, and without tracking onto the curb at corners.
Major Collector	Passenger cars, transit buses (S-40), single-unit trucks, conventional school buses and combination trucks must be able to turn easily from one street to the next and remain in the correct lane for each street, and without tracking onto the curb at corners.
Major and Minor Arterial	Passenger cars, transit buses (S-40), single-unit trucks, conventional school buses and combination trucks (WB-50) must be able to turn easily from one street to the next and remain in the correct lane for each street, and without tracking onto the curb at corners.
Freeway / Expressway	All approved vehicle types must be able to turn easily onto and off of Freeway/Expressway Ramps from adjacent streets and remain in the correct lane for each ramp/street. These are typically State of Tennessee roadways and shall meet all TDOT design vehicle requirements.

3.3.4 Minimum Turning Paths of Design Vehicles

All street and intersection geometric designs shall be evaluated to ensure that the minimum turning paths for the selected design vehicles can be safely and efficiently accommodated by the proposed street and intersection geometry.

3.3.5 Design Speed

There are two primary types of speeds that must be considered in the street design process. The first is “design” speed, which is the selected speed used to determine the various minimum geometric design features of the street. The second type is “operating” speed, which is the speed at which drivers operate their vehicles in free-flow conditions. The “85^{th} percentile speed” (the speed at which 85 percent of the vehicles travel at or less) is generally assumed to be the operating (and typically posted) speed of a street.

The design speed selected for street design purposes shall take into consideration several factors including street classification, adjacent land use, topography and sight distance, pedestrian and bicycle activity, and the desired operating speed of the facility. The design speed used in street design shall be approved by the City Engineer and shall generally be in accordance with **Table 3.3B** for desirable design speed by street classification:

3.3.6 Street and Lane Widths

(1) Street Widths

The minimum width of a street pavement section shall be determined by (1) its functional classification as identified in the Major Thoroughfare Plan, and (2) typical cross-sections as shown in the standard drawings. Other elements such as topography, special requirements identified in Circulation Plans and Traffic Impact Analysis (such as turn lanes and deceleration/acceleration lanes), and unique street design features may necessitate a change in the minimum street section width. The City Engineer will approve the final required street width.

(2) Lane Widths
The minimum and desirable widths of different types of lanes based on the street classification are provided in **Table 3.3A**, and as shown in the typical section drawings. These widths may be modified by the City Engineer based on the specific requirements of a street section.

3.3.7 Special Street Configurations

(1) Cul-de-Sacs

(a) Where Allowed: Cul-de-sacs are permitted only on Local Street classifications and shall not extend for more than five-hundred (500) feet (unless necessitated by topography and approved by the City Engineer) as measured from the center of the cul-de-sac turn around to the nearest right-of way boundary of the adjoining street right-of-way intersection. If adjoining properties, commercial or residential, install fire sprinkler systems, this length may be extended to 1000 feet in accordance with the adopted fire code. In no case shall a cul-de-sac or temporary dead end street serve more than twenty (20) single-family residential lots.

Typical Street Cul-de-Sac

(b) Secondary Access: Any Local Street with a cul-de-sac that exceeds the maximum lengths above shall be provided with a secondary access point.

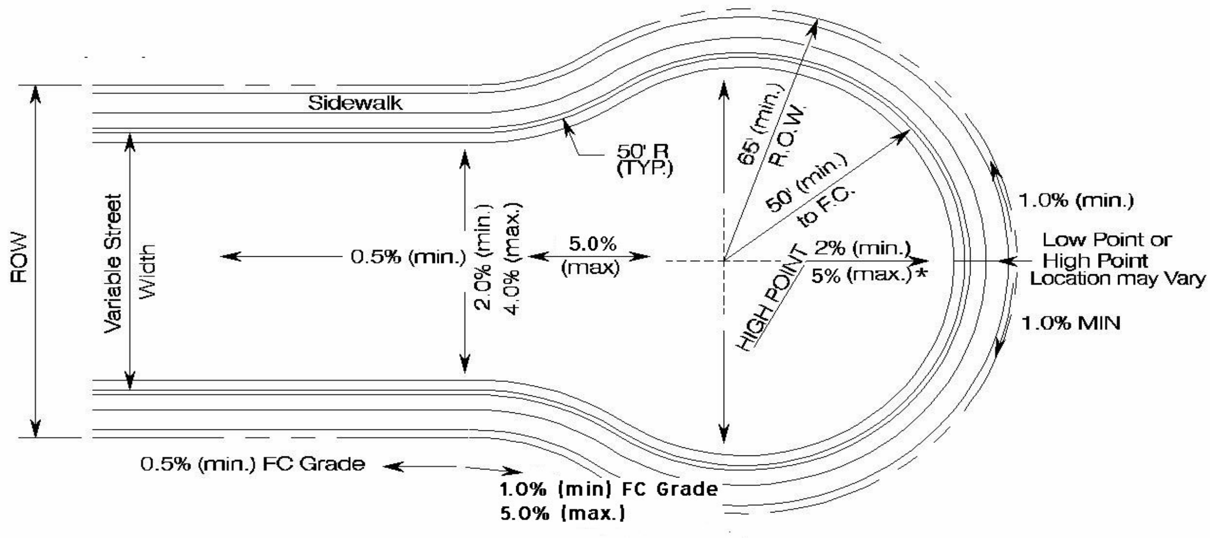
(c) Design Requirements: Cul-de-sac streets shall terminate in a circular turn around having a right-of-way radius of at least sixty-five (65) feet, and a paved radius of at least fifty (50) feet at its outside edge. The right-of-way radius may be reduced to sixty (60) feet where additional public utility and access easements are required and/or provided. Attached sidewalks are required and shall be a minimum of five (5) feet wide. These and other minimum requirements are illustrated in **Figure 3.3.7(1)c**.

(d) Prohibited Designs: All cul-de-sac designs must allow for automobiles and typical service vehicles to turn around without requiring backing maneuvers.

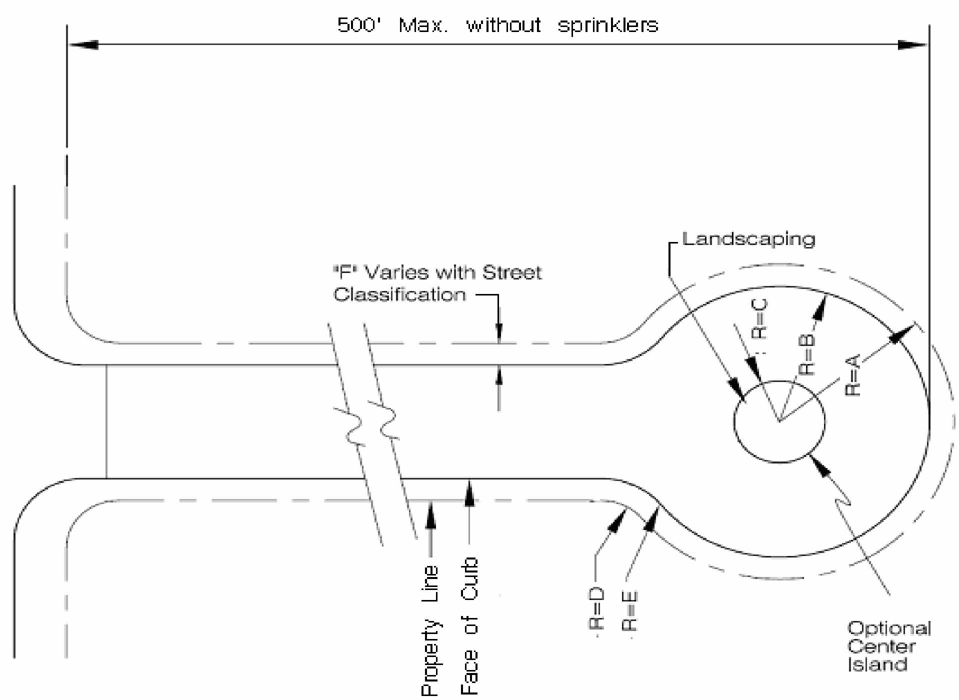
(e) Temporary Cul-de-Sac: Where a development is being implemented by sections, a temporary cul-de-sac may be used if the overall development plan allows the cul-de-sac to be eliminated at final build out of the development. The cul-de-sac shall be provided with an asphalt turn-around having a pavement radius of at least fifty (50) feet (no designs requiring backing maneuvers will be allowed). The right-of-way/easement radius shall be a minimum of sixty-five (65) feet in areas where there is no adjacent public utility and access easement, and a minimum of sixty (60) feet where public utility and access easements are required and/or provided. The City Engineer may waive the sidewalk and curb/gutter requirements for a temporary cul-de-sac provided the cul-de-sac is expected to be in use three (3) years or less, and interim pedestrian and drainage needs are addressed to the satisfaction of the City Engineer.

All temporary cul-de-sacs shall be constructed within dedicated street right-of-way or a dedicated Access Easement for those areas outside the tangent street right-of-way section. The Easement outside the tangent right-of-way section shall be vacated by the City when the Easement is no longer necessary. Application for vacation of the easement must be initiated and paid for by the Developer or property owner.

A sign must be provided at the end of the temporary cul-de-sac noting that the street will be extended in the future. Signing for temporary, dead-end streets shall be in accordance with the requirements of **Chapter 11, Traffic Signs and Markings**.
Requirements for temporary cul-de-sacs are shown in **Figure 3.3.7(1)e.**

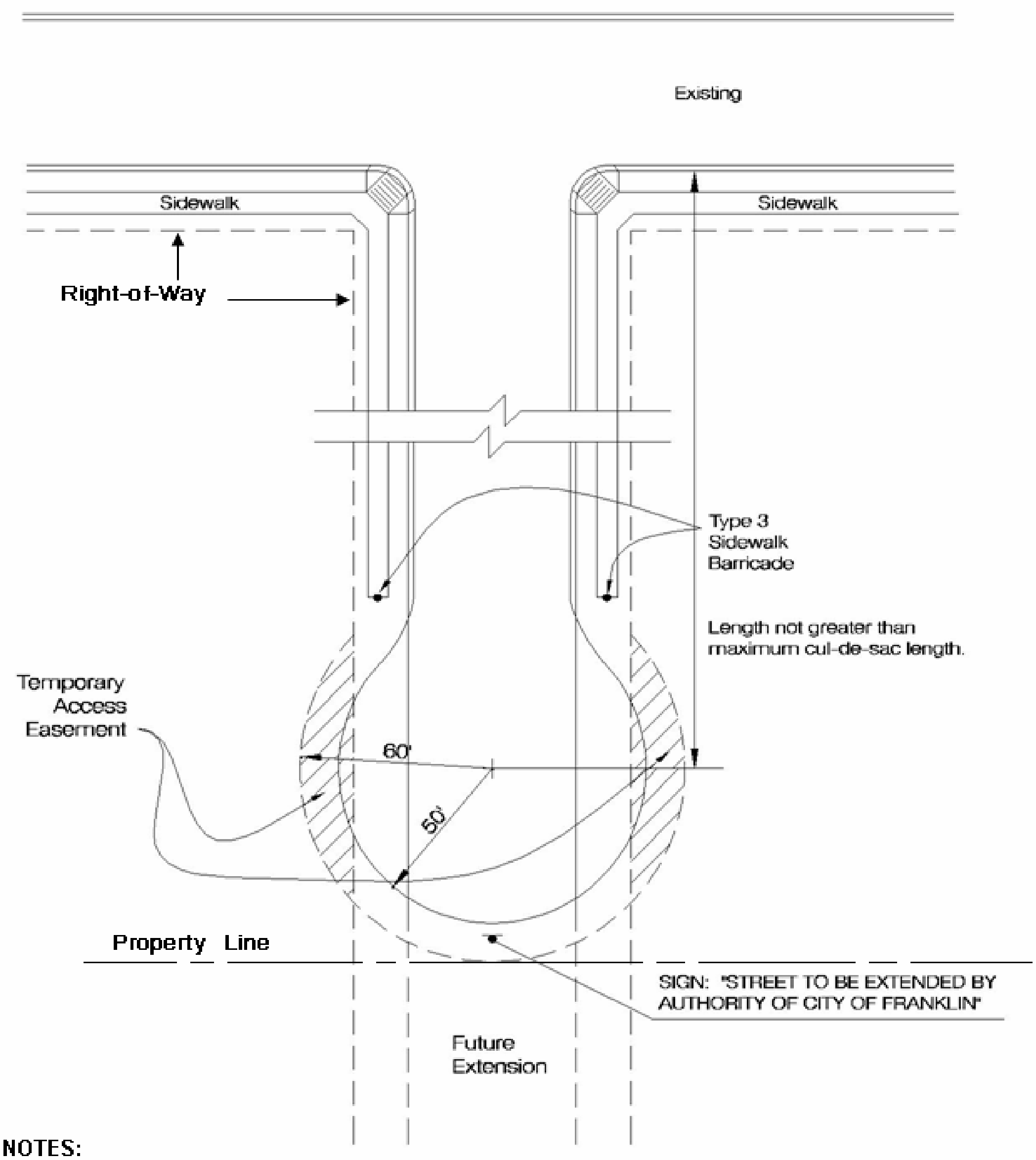


DRIVE-OVER CURB, GUTTER AND SIDEWALK



CLASSIFICATION OF CONNECTING STREET	RADIUS				
	A	B	C	D	E
LOCAL STREET	**B+F**	**50'**	**20'**	**E-F**	**50'**

Cul-de-Sac Design
Figure 3.3.7(1)c



NOTES:

1. A temporary easement is required for the temporary turnaround. The easment shall incorporate all of the all-weather surface, pavement and signage.
2. The turnaround shall consist of an all weather surface acceptable to the City Engineer.
3. Excess pavement to be removed with extension of stub street

Temporary Cul-de-Sac
Figure 3.3.7(1)e

(f) Cul-de-Sac Medians: A center median island may be permitted by the City Engineer where it can be demonstrated that all routine service vehicles and emergency vehicles can be readily accommodated to the satisfaction of the City Fire Department. The maximum diameter of the island curb face shall be twenty (20) feet.

(g) Cul-de-Sac Parking: Parking in a cul-de-sac is typically prohibited in order to allow adequate room for emergency and service vehicles to maneuver. If parking is proposed in the cul-de-sac, a plan shall be submitted to the City Engineer demonstrating that parked vehicles will not impede movements contemplated to be made by emergency vehicles. When on-street parking is allowed, the minimum cul-de-sac dimensions shown in **Figure 3.3.7(1)c** shall normally be increased by a minimum of eight (8) feet.

(2) Eyebrows

(a) Where Allowed: Eyebrows shall be permitted only on Local Streets. They may only be used in tangent sections or at intersection corners. Design of eyebrows shall be as shown in **Figure 3.3.7(2)a.**

(b) Design Requirements: Eyebrows shall be a minimum of twenty-five (25) feet in length and a maximum of fifty (50) feet measured along the flow-line. Lengths exceeding fifty (50) feet shall incorporate an island as approved by the City Engineer. Designs that require backing maneuvers for typical use vehicles will be prohibited.

Typical Eyebrow

(c) Location: The location of the eyebrow shall be in conformance with intersection spacing requirements as provided in **Section 3.3.25, Access Management**.

(3) Dead-End Streets

(a) Where Allowed: Permanent dead-end streets without cul-de-sac designs are prohibited.

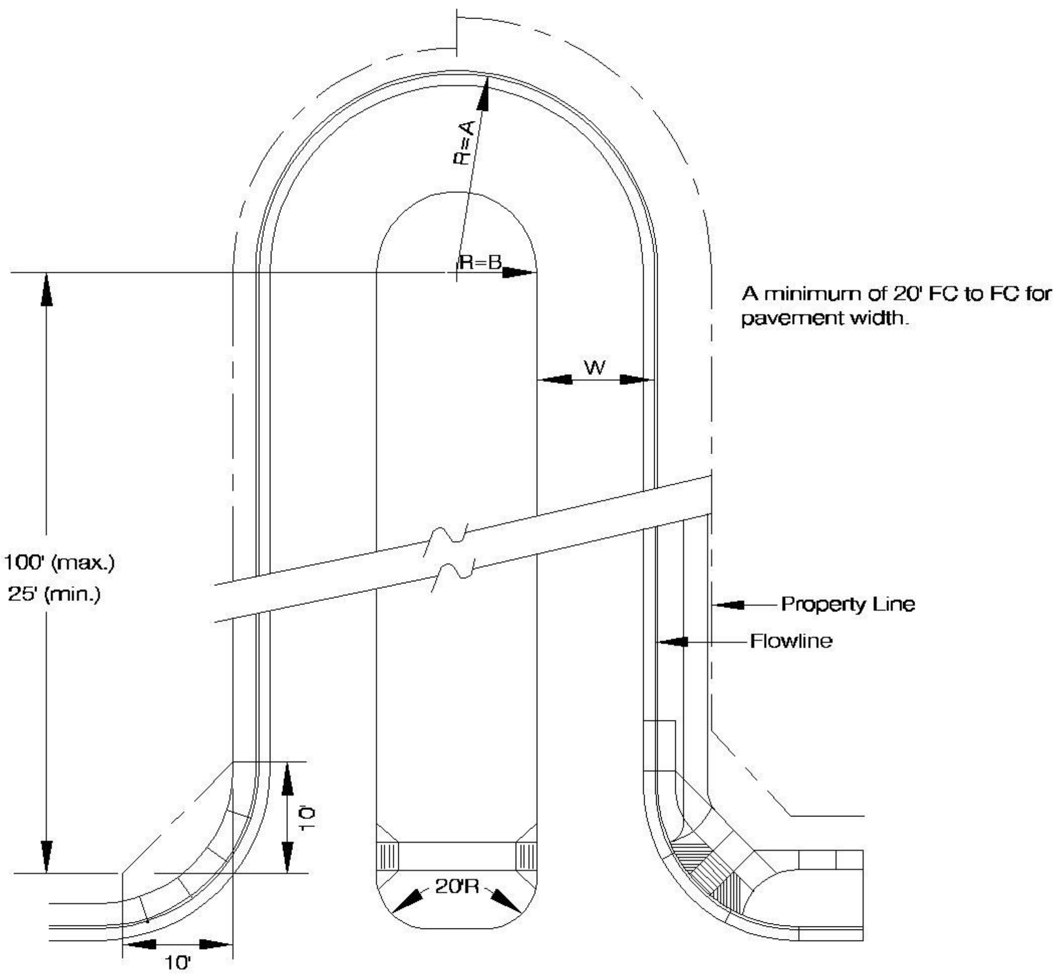
(b) "Stub" Streets: Temporary dead-end "stub" streets (without temporary cul-de-sacs) will only be permitted on Local Streets and at the discretion of the City Engineer. On residential local streets, "stub" streets shall not be longer than one residential lot. See **Figure 3.3.7(3)b** for design requirements of temporary dead-end "stub" streets.

(b) Temporary Turnaround: At locations where a planned through street is approved to be temporarily terminated and is longer than one residential lot, a temporary turnaround shall be constructed as outlined in **Section 3.3.7(1)(e)**. Asphalt pavement is required but no curb and gutter is required on temporary dead-end streets turnarounds.

(c) Easement Required: All temporary turnarounds shall be constructed within dedicated street right-of-way or a dedicated Access Easement for those areas outside the street right-of-way section. The Easement outside the street right-of-way shall be vacated by the City when the Easement is no longer necessary. Application for vacation of the easement must be initiated and paid for by the Developer or property owner.

(d) Signs Required: A sign must be provided at the temporary street end noting that the street will be extended in the future. Signing for temporary, dead-end streets shall be in accordance with the requirements of **Chapter 11, Traffic Signs and Markings**.

FIGURE 3.3.7(2)a EYEBROW DESIGN



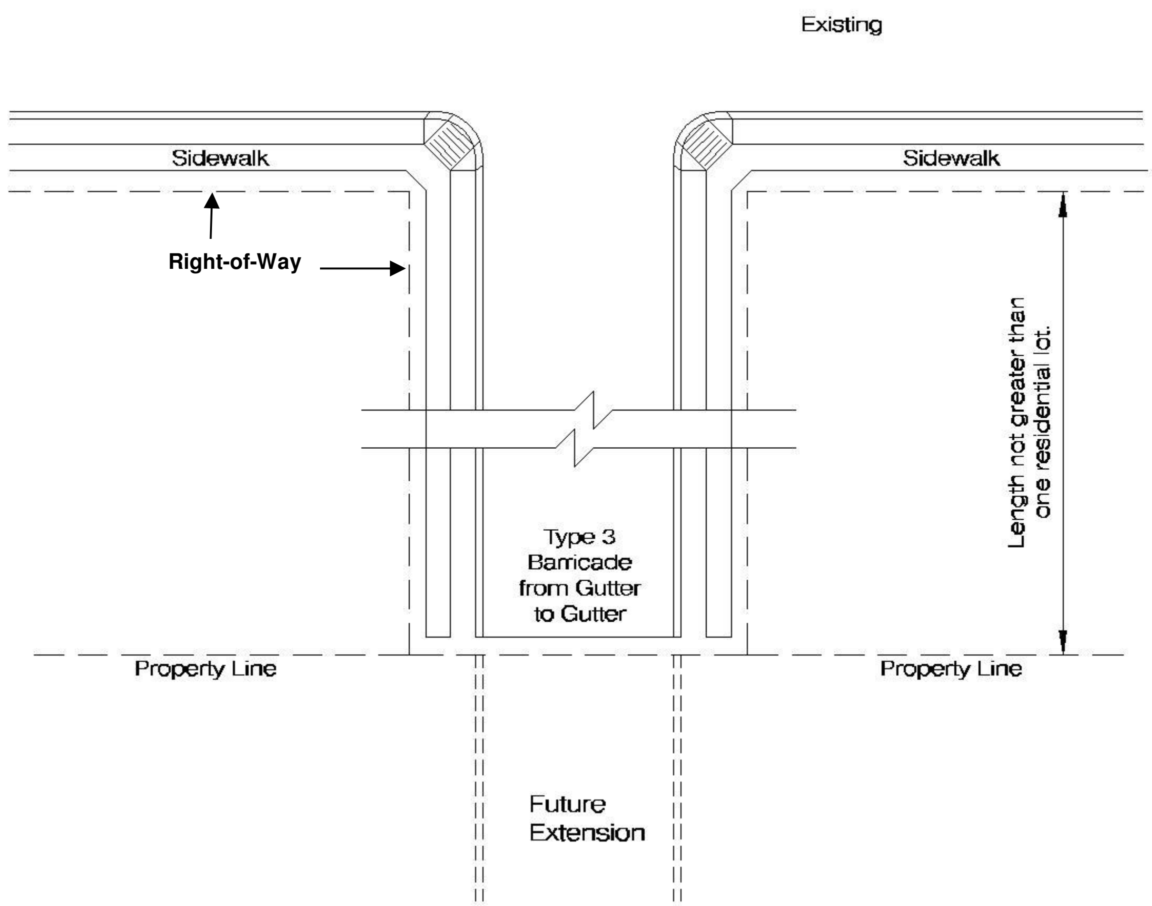
STREET CLASSIFICATION	RADIUS (MIN.) A	RADIUS (MIN.) B (MAX.)	No Parking W	Parking One Side W	Parking Two Sides W
LOCAL SINGLE FAMILY RESIDENTIAL	55'	30'	15'	23'	31'
LOCAL MULTIPLE FAMILY RESIDENTIAL	60'	30'	22'	30'	38'
LOCAL COMMERCIAL & INDUSTRIAL	65'	26'	24'	32'	38'
			Note 3	Note 4	

NOTES:

1. The sidewalk around the eyebrow shall be placed according to the street classification. The sidewalk across the street end of the Island is to be placed in the same location as on the cross street.
2. Median may be landscaped or hardscaped as required be the City Engineer and shall be maintained by a viable private party.
3. Offstreet parking at the rate of 1 space for each dwelling unit served by the eyebrow shall be provided in the median or in a perimeter parking bay.
4. When parking is restricted to one side, it shall be provided on the out-side of the street.

Eyebrow Design
Figure 3.3.7(2)a

FIGURE 3.3.7(3)b DEAD END STUB STREET



NOTES:

1. Stub Streets only allowed up to one residential lot in length.
2. Type III barricades are required with permanent installation methods across the street end including a ROAD CLOSED sign.
3. A second sign must be installed on the barricade noting that the street may be extended in the future.

Figure 3.3.7(3)b
Dead End Stub Street

(4) Half Streets
The City Engineer may allow the construction of half streets on Minor Collector and Local streets when only one side of a street right-of-way is available. A minimum of twenty-two (22) feet of pavement must be provided on any half street. In such cases, the property owner is responsible for right-of-way dedication and construction of the half of the new street section that is adjacent to their property. Typically, these partial street sections will be built to permanent street standards including all curb and gutter, drainage, sidewalks and other elements as called for in the typical section for that street classification. Additional dedication of street easement may be required by the City Engineer in these cases.

(5) Provisions for Future Public Street Intersections
Where provisions are to be made to intersect a future side street with the street being designed, the curb radii and pavement section of the future intersecting street "stub" shall typically be built to the end of the radii curb return. If the expected construction of the future street connection is anticipated to occur more than three (3) years after the primary street is constructed, then the street approach "stub" may be omitted and temporary curb, gutter and sidewalk improvements provided through this section. In such cases, the curb and gutter shall be concrete while the temporary sidewalk or path may be asphalt.

(6) Improvement of Annexed Streets
Streets annexed into the City may be required to meet these engineering standards before they are accepted as City streets. The City Engineer shall evaluate all proposed street annexations to determine their adherence to these standards, and any recommendations for improvements to meet minimum public safety, health and welfare requirements.

3.3.8 Horizontal Alignment

The design of horizontal curves in street design should be based on an appropriate relationship between design speed and curvature and on their joint relationships with superelevation and side friction. On Arterial and Major Collector streets, curve radii and tangents shall be as large as possible using the minimums only where necessary. However, minimum radius curves shall be used on Local and Collector streets unless otherwise required. Angle point direction changes are not allowed. All changes in direction shall be made using standard curves.

(1) Horizontal Curve Radii
The minimum allowable centerline radii for horizontal curves shall be as designated in **Table 3.3B.** Reverse and compound curves should be used only when a single radius curve will not work. For driver safety, compound curves shall preferably have a ratio no greater than one and one-half (1.5) where the value of the larger radius is divided by the smaller radius. When they are designed, TDOT and AASHTO design standards and procedures shall be used.

Based on typical conditions in the City, the absolute minimum and desirable horizontal curves for streets <u>without superelevation</u> are shown in **Table 3.3B**. This table also provides the minimum tangent distance between reverse curves.

The effect of grade should also be considered by the designer when selecting horizontal curvature. The design of more complex horizontal curve geometry should be conducted in accordance with TDOT *Roadway Design Guidelines* (latest edition) and the AASHTO *Green Book*.

(2) Minimum Tangent Length

(a) Intersection: Whenever a minor street intersects a street of higher classification, a tangent length (measured from the nearest gutter flow-line of the intersected street to the point of curvature in the intersecting street) shall be provided for a safe sight distance and safe traffic operation. The minimum required tangent lengths indicated in **Table 3.3B** apply to the minor leg(s) only. The angle of departure shall not exceed ten (10) degrees for the length of the tangent.

(b) **Reverse Curves:** Reverse curves in streets shall be separated by minimum tangents of between two-hundred (200) and one-hundred (100) feet for arterial and major collector streets as shown in **Table 3.3B**.

(c) **Broken Back Curves:** Two curves in the same direction (broken back curves) shall be separated by a tangent with a length of at least two (2) times the minimum length shown in **Table 3.3B.**

(3) Consistent Radii
All curves along a street shall be designed with radii that are approximately equal. The purpose of this limitation is to provide consistency and minimize unexpected difficult or quick maneuvers for the driver.

(4) Curves with Small Deflection Angles (10° or less)
To reduce the appearance of kinks in the street, minimum lengths of curve shall be designed with minimum arc lengths as shown in **Table 3.3.8(4).**

Table 3.3.8(4) Minimum Centerline Arc Length

Street Classification	Minimum Centerline Arc Length (ft)
Local – Residential	100
Local – Commercial & Industrial	200
Minor Collector	250
Major Collector – Residential	250
Major Collector – Commercial & Industrial	300
Minor Arterial	300
Major Arterial	400

(5) Horizontal Curves on Vertical Curves
For driver safety, horizontal curves should not begin near the top of a crest vertical curve nor near the bottom of a sag vertical curve.

(6) Sight Distance on Horizontal Curves
Where there are sight obstructions on the inside of curves or the inside of the median lane on divided streets, the designer will need to adjust the cross section elements or change the alignment if removal of the obstruction is impractical to provide adequate sight distance. These changes will be subject to approval by the City Engineer.

(7) Coefficient of Friction
The coefficient of friction shall conform to the values in the TDOT Standards or AASHTO *Green Book*, as appropriate.

(8) Off-Site Design Centerline, Flow-lines and Cross Sections
To assure that future street improvements will meet these Standards, the centerline, flow-line, and cross sections of all streets, except cul-de-sacs, shall be continued for five-hundred (500) feet beyond the proposed construction. The grade and ground lines of all arterials shall be continued an additional five-hundred (500) feet for a total of one-thousand (1000) feet beyond the end of the proposed construction.

(9) Joining Existing Improvements
Connection with existing streets shall be made to match the existing alignment grade of the existing improvements, in accordance with horizontal alignment criteria.

(10) Cross Slope
Cross slope on a pavement is provided to drain water from the street surface. The design of cross slope shall consider driver comfort and safety.

(a) **Minimum Cross Slope:** A minimum cross slope on all new streets shall be two (2.0) percent. Minimum cross slope on reconstruction or overlays is one and one-half (1.5) percent. All other values of cross slope shall be independently reviewed and approved by the City Engineer.

(b) Maximum Allowable Cross Slope: Maximum allowable tangent cross slope on all new construction shall be two (2.0) percent. Maximum allowable cross slope on any reconstruction or overlays of existing streets shall be four (4.0) percent.

(c) Cross Slope for Street Modifications: When widening an existing street or adding turn lanes to an existing street, the resulting cross slope of the widened portion shall be within the limits stated above and the new Cross Slope shall be no less than the existing cross slope. However, if the cross slope of the existing street exceeds the Standards then new curb and gutter shall be designed such that the existing pavement, when overlaid, will result in a straight line cross slope grade that meets these Standards. Alternatively, the existing pavement may be removed and re-profiled to comply with these Standards.

(d) Cross Slope for Cul-de-Sacs: The typical cross-slope to be used on street design in the City is two (2.0) percent. Refer to **Figure 3.3.7(1)d** for more information on cul-de-sac bulb cross slopes.

(11) Superelevation on Horizontal Curves
The purpose of superelevating a street is to maintain the riding comfort on horizontal curves. Superelevation is not typically used on streets in the City with design speeds at or less than 45 MPH. For design speeds higher than 45 MPH or where superelevation is required or preferred, TDOT and AASHTO design standards and procedures shall be used. The following criteria shall be followed:

(a) Where Superelevation Is Permitted: Superelevation may be allowed for curves on Arterial and Major Collector streets. In no case shall superelevation exceed four (4.0) percent cross slopes. As specified in **Table 3.3A** and **Table 3.3B**, superelevation shall not be used on Local or Minor Collector Streets.

(b) Transition Length: When superelevation is used, use the TDOT method of a 50/50 split of the transition length each side of the tangent point

(c) Drainage: Where superelevation is used, the gutter shall always be an inflow type. The water must enter a storm sewer system or other acceptable outlet from the street rather than crossing the street in sheet flow. Where medians are present in a super-elevated section, water may be allowed to sheet flow from the median to the street gutter.

3.3.9 Vertical Alignment

The design of vertical curves in street design should be simple in application and should result in a design that is safe and comfortable in operation, pleasing in appearance and adequate for drainage.

(1) Maximum and Minimum Grades for Streets
The maximum and minimum grades for specific street classifications are shown in to **Tables 3.3A and 3.3B**. The centerline grade in the bulb of a cul-de-sac shall not exceed five (5.0) percent.

(2) Grade Breaks
No single point grade break shall exceed four-tenths (0.40) percent, except for the flow line in sag curves where the maximum grade break is one (1.0) percent. In curb returns, a grade break may be as great as three (3.0) percent for extreme circumstances.

(3) Minimum Flow-line Grades
Minimum flow-line grades for gutters shall be one-half (0.50) percent, except in the bulb of cul-de-sacs where the minimum shall be one (1.0) percent.

(4) Grades Through Intersections
The profile grade lines on the legs of an intersection should be adjusted for a distance back from the intersection to provide a smooth junction and proper drainage. Normally, the grade line of the major street should be carried through the intersection and that of the minor street should be adjusted to it. Any changes in profile through an intersection should meet the crest and sag curve criteria noted below, to the extent deemed practical. The City Engineer shall approve all variations from these criteria.

Intersection approach grades should consider the deceleration and acceleration that occurs due to traffic control and turning movements. It is desirable to provide near-level intersection approach grades to improve operations and safety within the intersection area. Maximum intersection approach grades are shown in **Table 3.3.9(4).**

Table 3.3.9(4) Maximum Grades

Classification	Maximum Grade	Maximum Grade Approaching Signalized Intersection
Freeway	Determined by TDOT	n/a
Expressway	Determined by TDOT	2 % for 600 ft.
Major Arterial	6 %	2 % for 500 ft.
Minor Arterial	7 %	2 % for 500 ft.
Major Collector Commercial/Industrial	8 %	3 % for 400 ft. **
Major Collector Residential	10 %	3 % for 300 ft.
Minor Collector	10 %	3 % for 300 ft.
Local Commercial/Industrial	8 %	4 % for 200 ft. **
Local Residential *	14 %*	4 % for 100 ft.
Cul-de-Sac	5 %	n/a
Alley	8 %	n/a

* Maximum desirable grade is 10% unless existing conditions justify the use of a higher grade. When a higher grade is proposed, it must be approved by the City Engineer to ensure ease of service for emergency and service vehicles.

** Concrete pavement may be required to maintain acceptable pavement conditions on steep sections.

(5) Requirements for Using Vertical Curves

The major control for safe operation on "crest" vertical curves is the provision of ample sight distance for the design speed. Crest vertical curves should be designed to at least provide the minimum stopping sight distance shown in **Table 3.3B**.

The design of "sag" vertical curves is controlled by headlight distance, passenger comfort, drainage control and general street appearance. At under-crossings the structure may limit sight distance which could cause the need for higher K factors to achieve adequate stopping sight distance.

Both centerlines and the curb and gutter flow-lines shall be designed with vertical curves to meet AASHTO *Green Book* requirements. A series of grade breaks may be used in lieu of a specified vertical curve as long as the series of breaks meet the vertical curve criteria in these Standards for the design speed. In sag curves on flow line, the minimum grade requirement shall override the slope within the vertical curve.

(a) Minimum Length Crest and Sag: The AASHTO *Green Book* gives minimum length of crest and sag vertical curves for various algebraic differences in grade. Street designs shall meet or exceed these minimums. The minimum length of vertical curve shall be fifty (50) feet. The minimum rate of vertical curvature (K) on crest and sag vertical curves are shown in **Table 3.3B**. The "K" value is the length of curve per percent algebraic difference in intersecting grades. Vertical curves should be designed for any grade change in excess of one-half (0.50) percent.

(b) Crest Curves: For crest curves, the street centerline, curb, and gutter shall be designed with vertical curves in accordance with minimum requirements shown in the AASHTO *Green Book*.

(c) Sump Sag Curves: For sag curves the street centerline shall be designed with a vertical curve with minimum length as shown in the AASHTO *Green Book***.** The minimum flow-line grade on a sag curve shall be one-half (0.5) percent. Curb and gutter shall be constructed in a series of tangent sections with a minimum slope of one-half (0.5) percent.

(d) Sight Distance: The values in **Table 3.3.9(5)d** are for streets without passing zones or underpasses. If either of these conditions is being contemplated, curvature should be designed that allows for adequate stopping and passing sight distance for these conditions.

Table 3.3.9(5)d Stopping Sight Distance and Rate of Vertical Curve			
Design Speed (MPH)	Stopping Sight Distance (ft)	Rate (K) of Crest Vertical Curve	Rate (K) of Sag Vertical Curve
20	115	7	17
25	155	12	26
30	200	19	37
35	250	29	49
40	305	44	64
45	360	61	79
50	425	84	96
55	495	114	115

(6) Joining Existing Improvements
Connection with existing streets shall be made to match the existing grade of the existing improvements, in accordance with vertical alignment criteria (grade breaks shall not exceed allowable).

(7) Vertical Clearance
Vertical clearance above a street shall be a minimum of fourteen and three-tenths (14.3) feet unless the street is designated as a truck route, then the minimum vertical clearance shall be sixteen and one-half (16.5) feet. The City Engineer may require greater clearance when considered necessary to meet future street operation requirements.

(8) Off-Site Continuance of Grade and Ground Lines
To assure that future street improvements will meet these Standards the grade and ground lines of all local and collector streets, except cul-de-sacs, shall be continued on the plans for five-hundred (500) feet beyond the proposed construction. The grade and ground lines of all arterials shall be continued one-thousand (1000) feet beyond the end of the proposed construction.

(9) Coordinating Horizontal and Vertical Alignments
Horizontal and vertical design should not be designed independently. Horizontal alignment and profile are among the more important design elements of a street. Their effective combination increases safety, encourages uniform speed, and improves appearance. Some general guidelines for their relationships are:

(a) Curves and grades should be in proper balance. The designer shall not combine extreme horizontal and/or vertical conditions or introduce significant curves at the end of long tangent sections or flat grades.

(b) Sharp horizontal curvature should not be introduced at or near the top of a pronounced crest vertical curve, nor should it be introduced near the bottom of a steep grade approaching or near the low point of a pronounced sag vertical curve.

(c) Both horizontal and vertical curvature and profile should be made as flat as practical at intersections where sight distance along both streets is important and vehicles may have to slow or stop.

(d) Designers should begin evaluating horizontal alignment and profile in the preliminary design stage. Proposed alignment and profile should be submitted to the City for review and comment prior to advancing the design process.

3.3.10 Sight Distance

(1) General
Sight distance is the distance necessary for a vehicle operator to perform expected functions and be able to do so without causing a hazard for the driver or other vehicle operators for the specific design speed of the street. Vehicles shall perform moves without causing other vehicles to slow from the average running speed. In no case shall the distance be less than the stopping sight distance. This includes visibility at intersections and driveways as well as around curves and roadside encroachments.

All streets designed in the City shall provide adequate sight distance for all types of users, considering both horizontal and vertical alignment. Sight distance should be carefully considered in the preliminary stages of design when both the horizontal and vertical alignment may still be subject to adjustment. Specific sight distance requirements include:

- Stopping Sight Distance – The distance required for a vehicle traveling at or near the design speed to detect and safely stop before reaching a stationary object in its path.
- Decision Sight Distance – The distance needed for a driver to detect an unexpected or otherwise difficult-to-perceive information source or condition in a street environment that may be visually cluttered, recognize the condition or it's potential threat, select an appropriate speed or path, and initiate and complete the maneuver safely and efficiently.
- Intersection Sight Distance – The distance needed at an intersection for an approaching driver to perceive the presence of potentially conflicting vehicles in order to stop or adjust their speed to avoid collisions, or for a driver stopped at an intersection to view potentially conflicting vehicles before entering or crossing an intersection.

(2) Criteria for Measuring Sight Distance
For sight distance calculations, the height of the driver's eye shall be assumed to be three and one-half (3.5) feet above the street's surface. For stopping sight distance calculations, the height of an object shall be assumed to be two (2) feet above the street surface. For intersection sight distance calculations, the height of the intersecting vehicle shall be assumed to be three and one-half (3.5) feet above the surface of the intersecting street. The designer shall consider the impacts of grades and vertical curvature in calculating sight distance.

(3) Sight Obstructions
Any object within a sight distance triangle more than twenty-four (24) inches above the flow-line elevation of the adjacent street shall constitute a sight obstruction, and shall be removed or lowered. Such objects include but are not limited to berms, buildings, parked vehicles on private property, cut slopes, hedges, trees, shrubs, mailbox clusters, utility cabinets or tall crops. Since vehicles parked on-street are under the control of the City, parked vehicles shall not be considered an obstruction for design purposes. The city may limit parking to protect visibility as needed. The sight distance shall be measured to the approach lane positions as shown in **Figure 3.3.10(3**). In no case shall any permanent object encroach into the line-of-sight of any part of the sight distance triangle. Street trees within the sight distance easement may be excepted from this requirement if pruned up to eight (8) feet, and the trunks at maturity do not collectively hinder sight lines as determined by the City Engineer. The shaded portion of the diagram depicts the sight triangle area where site element heights and locations are strictly limited.

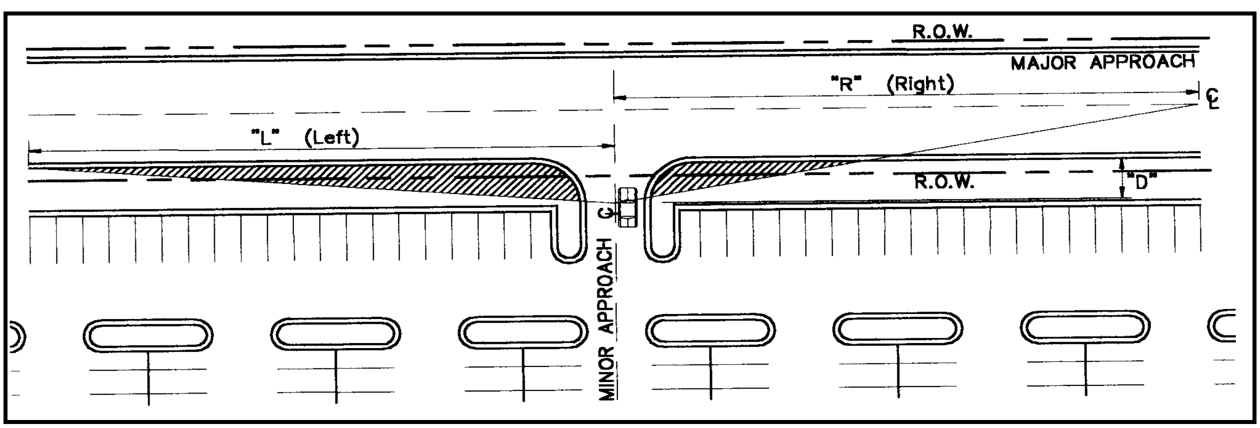


Figure 3.3.10(3) Intersection Sight Distance Triangle

During the street design process, the designer shall identify and correct for any sight obstructions that could limit the driver's sight distance beyond the distances noted above. This process shall investigate both the vertical and horizontal plane for sight obstructions. No landscaping or hardscaping shall be permitted within a corner area that will block the line of sight for pedestrian visibility (not higher than twenty-four (24) inches and possibly less depending on street geometry).

Street intersections shall be designed so that adequate sight distance is provided along all streets. The required sight distance shall be determined by the design speed and grades of the street and the acceleration rate of an average vehicle. In addition, for all streets that intersect with Arterial and Collector streets, the sight distance must be large enough to allow a vehicle to enter the street and accelerate to the average running speed without interfering with the traffic flow on the Arterial or Collector Street. Intersection sight distance is generally determined based on the different types of traffic control at an intersection. In most cases sight distance triangles will be required as described below. The different situations, or cases, that must be considered are defined in the following discussion.

(4) Sight Distance Easements
All sight distance easements must be shown on the street plan/profile plans. All necessary sight distances must be within the public right-of-way or a sight distance easement dedicated to the City. When the line of sight crosses onto private property, a “Sight Distance Easement” shall be dedicated to provide the required clear sight distance. The easement or right-of-way shall be dedicated to the City; however, maintenance shall be the responsibility of a private entity such as the property owner or the appropriate home owners association (HOA).

(5) Stopping Sight Distance

(a) Vertical Curves: Stopping sight distance is calculated according to the AASHTO *Green Book*, *Chapter III*, as shown in **Figure 3.3.10(5a).** Object height is assumed to be two (2) feet above the street surface and the viewer’s height is assumed to be three and one-half (3.5) feet above street surface. Where an object off the pavement restricts sight distance, the minimum radius of curvature is determined by the stopping sight distance. In no case shall the stopping sight distance be less than as specified in **Table 3.3.10(5a)**. The sight distance design procedure shall assume a six (6) foot high fence (as measured from actual finished grade) exists at all property lines except in the sight-distance easements that may be required to preserve the needed sight distance.

(b) Horizontal Curves: Stopping sight distance on horizontal curves is based upon lateral clearance from the inner edge of pavement to sight obstruction, for various radii of inner edge of pavement and design speeds. The position of the driver’s eye and the object sighted shall be assumed to be six (6) feet from the inner edge of pavement, with the sight distance being measured along this arc. Stopping sight distances are given in **Table 3.3.10(5a).**

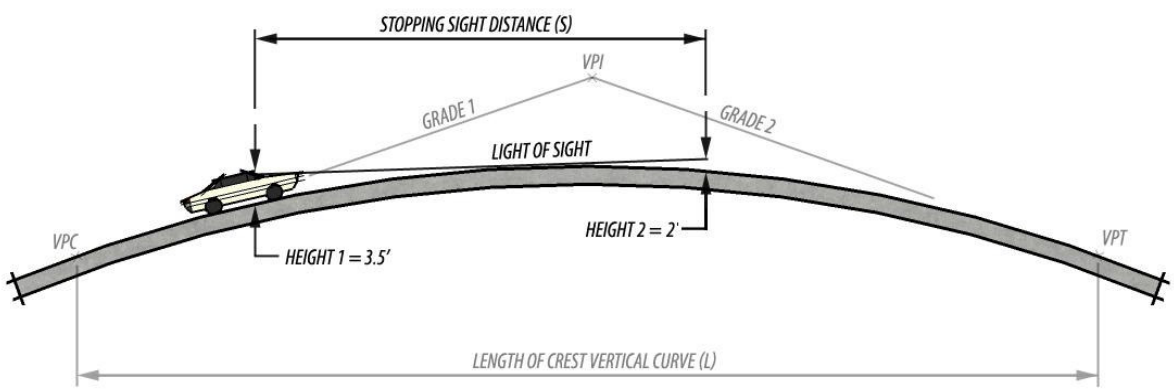


Figure 3.3.10(5a) Stopping Sight Distance

Table 3.3.10(5)a Stopping and Passing Sight Distance		
Design Speed (MPH)	Stopping Sight Distance (ft)	Passing Sight Distance (ft)
20	115	710
25	155	900
30	200	1090
35	250	1280
40	305	1470
45	360	1625
50	425	1835
55	495	1985

(c) Passing Sight Distance (Rural Situations Only)
Two-lane streets shall provide adequate passing zones where authorized by the City Engineer. Required passing sight distance for given design speeds is given in **Table 3.3.10(5a)**. Passing zones may be provided on two (2) lane streets which are classified as Arterials or Major Collectors.

(6) Intersection Sight Distance
Intersection sight distance triangles provide adequate visibility for vehicles to safely make turns and travel through intersections. Exceptions for roadway safety appurtenances may be approved by the City Engineer. The minimum corner sight distance triangle in the City is twenty (20) feet. Corner sight distance shall be measured as shown in **Figure 3.3.10(3)**.

(a) On corner lots, no fence, wall, hedge, planting, or structure between a height of two and one-half (2.5) feet and ten (10) feet above the centerline grades of the intersecting streets shall be erected, placed, or maintained within the triangular area formed by the right-of-way lines and a straight line joining the right-of-way lines twenty (20) feet from the right-of-way intersection. In cases of rounded right-of-way lines at intersecting streets, the measurement shall be made from the point of intersection of the tangents of the curve constituting the rounding.

(b) No fence, landscape, object, structure, vegetation, or wall shall be erected, maintained, or planted except for those meeting the requirements set forth below, within the sight triangle at an elevation greater than two and one-half (2.5) feet above the crown of pavement on the adjacent roadway. A sight triangle shall be defined by the table distances shown in **Table 3.3.10(6)c**.

(c) The distance "D" shall measure twenty (20) feet and fifteen (15) feet from the edge of the nearest motor vehicle travel lane for a public street and private driveway, respectively. The distance "L" shall be measured from the centerline of the minor approach to a point at the edge of the nearest travel lane. The distance "R" shall be measured from the centerline of the minor street to a point on the centerline of the major street approach. Minimum required sight distances for different posted speed limits shall be as follows:

Table 3.3.10(6)c Minimum Sight Distance from Side Street	
Posted Speed Limit (MPH)	Minimum Sight Distance (L & R) (feet)
25	200
30	250
35	325
40	400
45	475
50	550
55	650

(d) Sight triangles shall be measured from the minor leg of the intersection of two public streets where the minor approach shall be defined as that approach whose right-of-way is controlled by a stop sign and whose major approach is uncontrolled. At a signalized intersection of two public streets, sight triangles shall be measured for all approaches. For an intersection of a public street and private driveway, the sight distance is measured from the private driveway only.

(e) For developments where the entire street frontage is within a sight triangle, the required perimeter planting strip trees, front yard buffer trees, and/or street trees for this frontage shall be planted in the nearest adjacent area.

(f) In the traditional area, objects may be permitted within the sight triangle; however, regardless of area, no object shall be approved if it would create an unsafe obstruction in the opinion of the City Engineer.

Case A – Intersections without signalization

For intersections with no control the driver of the vehicle approaching an intersection should be able to see potentially conflicting vehicles in sufficient time to stop before reaching the intersection. These viewing areas are designated by approach sight triangles. The minimum distance of the sight triangle legs shall be based on design speed and in conformance with **Table 3.3.10(6)f**. For approach grades greater than three percent (3%), these distances should be adjusted as recommended in the AASHTO *Green Book*.

Case B – Intersections with stop control on the minor street

Departure sight triangles are required on intersection approaches with stop control. The dimensions of these sight triangles are discussed for each case below.

Case B1 – Left turn from the minor street

Vehicles turning left from a stopped intersection approach should be able to safely see oncoming traffic in both directions. The distances required to provide that sight distance are shown in **Table 3.3.10(6)f.**

Case B2 – Right turn from the minor street

Vehicles turning right from a stopped intersection approach should be able to safely see oncoming traffic from the left. The distances required to provide that sight distance are shown in **Table 3.3.10(6)f**.

Case B3 – Crossing maneuver from the minor street

Vehicles crossing an intersection from a stopped intersection approach should be able to see oncoming traffic in both directions. The distances required to provide that sight distance are the same as in Case B2 and are shown in **Table 3.3.10(6)f**.

Table 3.3.10(6)f Sight Distance for Case A & B

Design Speed (MPH)	Decision Sight Distance (ft)	Case A Approach Sight Triangle Leg Length (ft) (Major and Minor)	Case B1 Left Turn Sight Distance From Stop (ft) (Major and Minor)	Case B2, B3 Right Turn and Crossing Sight Distance (ft) (Major and Minor)
20	-	90	225	195
25	-	115	280	240
30	620	140	335	290
35	720	165	390	335
40	825	195	445	385
45	930	220	500	430
50	1030	245	555	480
55	1135	285	610	530

Case C – Intersections with yield control on the minor street
For four-leg intersections with yield control on the minor street, both sight triangles should be provided in order to provide sight distance for right or left turns and crossing maneuvers. Each situation is discussed below.

Case C1 – Crossing maneuver from the minor street
Drivers approaching a yield controlled intersection approach must be able to see and respond to oncoming traffic before entering and crossing the intersection. For design purposes, it is assumed that the vehicle approaching the yield sign slows to sixty percent (60%) of the approach design speed, and that the design speed for that approach is between 20 MPH and 50 MPH. The resultant length of the sight triangle legs along the approach street and major street are shown in **Table 3.3.10(6)g**.

Case C2 – Left or right turn from the minor street
Drivers approaching a yield controlled intersection approach must be able to see and respond to oncoming traffic before turning right or left at the intersection. For design purposes, it is assumed that the vehicle approaching the yield sign slows to 10 MPH for turning maneuvers. The resultant length of the leg of the approach sight triangle along the approach street to accommodate left and right turns without stopping should be a minimum of eighty-two (82) feet. The length of the sight triangle leg along the major street is shown in **Table 3.3.10(6)g.**

Case D – Intersections with traffic signal control
At signalized intersection, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on the other approaches. Left turning vehicles should have sufficient sight distance to select gaps in oncoming traffic and complete their turns. However, if the signal may be placed on flashing operation, then the appropriate departure sight distance triangles should be provided.

Case E – Intersections with all-way stop control
At intersections with all-way stop control, the first stopped vehicle on one approach should be visible to the drivers of the first stopped vehicles on other approaches. There are no other sight distance requirements for this type intersection. However, in the event that a stop sign is damaged or removed from an approach, a minimum corner sight distance should be provided. In this case, that minimum sight distance along each leg shall be twenty (20) feet.

Case F – Left turns from the major street
At locations where left turns or U-turns are allowed, adequate sight distance should be provided to accommodate those maneuvers. It is assumed that left or U-turn vehicles will be in a stopped condition. The sight distance required for this case is shown in **Table 3.3.10(6)g**.

Table 3.3.10(6)g Sight Distance for Case C & F

Design Speed (MPH)	Case C1 Crossing Maneuver Sight Distance Along Minor Leg (ft)	Case C1 Crossing Maneuver Sight Distance Along Major Leg (ft)	Case C2 Left or Right Turn Sight Distance Along Major Leg (ft)	Case F Left Turn Sight Distance From Major Street (ft)
20	100	195	240	165
25	130	240	295	205
30	160	290	355	245
35	195	335	415	285
40	235	385	475	325
45	275	430	530	365
50	320	480	590	405
55	370	530	650	445

The distances in the above tables are considered minimum requirements for stopping, decision and intersection sight distance for passenger cars at right-angle or nearly right-angle intersections. These distances should be adjusted by the designer for grade, intersection skew, vehicle type and other local conditions. They also may be increased by the City Engineer based upon the specific conditions of the street or intersection being designed.

3.3.11 Lane Transitions

Lane transitions are necessary when through lanes require lateral transitions without the use of horizontal curves. Also, when constructing a street that will directly connect with an existing street of different width, it is necessary to install a transition taper between the two. The length of taper depends upon the lateral offset distances between the outside traveled edge of the two sections and the design speed of the roadway. Formulas for determining transition taper lengths are shown below:

For Speeds ≤ 40 MPH: $$L = \frac{W * S^2}{60}$$

For Speeds > 40 MPH: $$L = W * S$$

Where: L = transition taper length, feet
W = width of pavement offset, feet
S = roadway design speed, MPH

When transition tapers are located on a curve, the separate halves of the roadway should be designed with different curves to create the taper without any angle points in the curvature.

3.3.12 Auxiliary Lanes

Auxiliary through lanes may be required along sections of any arterial or collector street to address existing or projected capacity or safety issues, at the determination of the City Engineer.

3.3.13 Intersections

Intersections shall be designed to provide for the safety of motorists, pedestrians, and bicyclists. Designs should generally be based on criteria from the Institute of Transportation Engineers *Traffic Engineering Handbook*, AASHTO's *Green Book*, and the FHWA *Interactive Intersection Diagnostic Review Model*.

Typical Intersection of Arterial Streets

(1) Basic Intersection Design
By their nature, intersections are conflict locations. Vehicles, pedestrians, and bicycles all cross paths. Each crossing is a conflict point. Intersections contain many conflict points. The basic design of intersections includes the following objectives:

- Minimize points of conflict;
- Simplify areas of conflict;
- Limit conflict frequency; and
- Limit conflict severity.

These objectives can be achieved using the design elements presented as follows.

(2) Minimum Number of Intersection Turn Lanes
Intersections planned and constructed in the City should allow for a minimum number of lanes to provide acceptable levels of traffic operations. **Table 3.3.13(2)** identifies the minimum number of turn lanes to be provided at typical arterial, collector and local street intersections. The City Engineer may increase or decrease these requirements based on a traffic impact analysis or other relevant factors.

Table 3.3.13(2) Typical Minimum Intersection/Interchange Requirements						
Class	Intersecting With A:					
	Major Arterial	Minor Arterial	Major Collector	Minor Collector	Commercial & Industrial Local	Residential Local
Major Arterial	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Should not connect	Should not connect
Minor Arterial	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts on Arterial	Separate Rights on Arterial Lefts on Collector	Separate Rights on Arterial Lefts on Collector	Should not connect	Should not connect
Major Collector	Separate Rights Double Lefts Possible Interchange	Separate rights Single lefts	Single lefts Possible separate Rights Possible roundabout	Single lefts Possible separate Rights Possible roundabout	Possible Lefts on Collector	Possible Lefts on Collector
Minor Collector	Separate Rights Double Lefts Possible Interchange	Separate rights Single lefts	Single lefts Possible separate Rights Possible roundabout	Single lefts Possible separate Rights Possible roundabout	Possible Lefts on Collector	Possible Lefts on Collector
Commercial & Industrial Local	Should not connect	Possible Lefts on Arterial	Possible Lefts on Collector Possible roundabout	Possible Lefts on Collector Possible roundabout	Possible roundabout	Should not connect
Residential Local	Should not connect	Should not connect	Possible Lefts on Collector Possible roundabout	Possible Lefts on Collector Possible roundabout	Possible roundabout	Possible roundabout

NOTE: It is assumed that , at a minimum, single left turn lanes will be provided at all public street intersections along major streets, and will also be provided on any collector approach to an arterial street.

(3) Location of Intersections
Intersections create turning movements and therefore conflict points in the traffic stream. It is therefore essential that they be carefully planned, located and designed to function effectively and safely. For intersection location criteria, refer to **Section 3.3.25, Access Management and Design**.

(4) Spacing of Intersections
Intersections with arterial and major collector streets shall be as shown on the Major Thoroughfare Plan. When not shown, intersection spacing shall be determined based on a traffic circulation and operations analysis considering elements such as left and right turn lane requirements, traffic weaving movements, location of private access points, and traffic signal coordination. In no case shall these intersections be less than eight-hundred (800) feet apart. Street jogs and/or intersections on minor collector and local streets of less than two-hundred (200) feet shall not be allowed, except where both intersecting streets are cul-de-sacs in which case the street jogs with centerline offsets of less than one hundred and twenty-five (125) feet shall not be allowed.

(5) Lane Alignment
All lanes shall be in alignment through each intersection, with a maximum of a two (2) foot shift in a hardship situation only, subject to approval by the City Engineer. Should a shift of greater than two (2) feet be allowed, special markings and signs may be required to support that shift design.

(6) Angle of Intersection
Crossing streets should intersect at ninety (90) degrees whenever possible. In no case shall they intersect at less than eighty (80) degrees or more than one-hundred (100) degrees.

(7) Horizontal Alignment and Vertical Profile

(a) Horizontal: The horizontal alignment of streets through an intersection shall be designed in conformance with **Tables 3.3A and 3.3B**. Intersections may be placed on horizontal curves, provided that the tangent lengths given in **Tables 3.3A and 3.3B** are provided on the minor street and the required intersection sight distance is met.

(b) Vertical: The street profile grade shall not exceed the percentages shown in **Table 3.3.9(4)** for the approaches to the intersection, as measured along the centerline of the street. The profile grade within the intersection streets shall not exceed three (3) percent.

(c) Prevailing Street Grade: The grade of the street with the higher classification shall prevail at intersections. The lesser street shall adapt to the grade of the major street. Grading of adjacent property and driveways shall adapt to the street grades. When streets are of equal classification, the City Engineer shall determine which street grade prevails.

(8) Exclusive Left Turn Lanes
Exclusive left turn lanes shall be provided on all arterial streets and other streets wherever left turn lanes are specified as needed by an access plan, required by these Specifications or warranted and approved by the City Engineer. The Designer shall use information in the traffic impact study, when available, to determine whether an exclusive left turn lane is warranted on non-arterial streets. To determine warrants, the following criteria shall be followed (as modified) from the *National Cooperative Highway Research Program Report 279 (NCHRP 279)*:

(a) At Signalized Intersections: A separate left turn lane shall normally be required if one of the following criteria is met:

i. The left turn design volume is at least 20 percent of total approach volumes, or
ii. The left turn design volume exceeds 100 vph in peak periods, or
iii. The LOS "C" criteria are not satisfied without a separate left turn lane.

The traffic impact analysis (TIA) shall make recommendations for the location and dimensions of all left turn lanes.

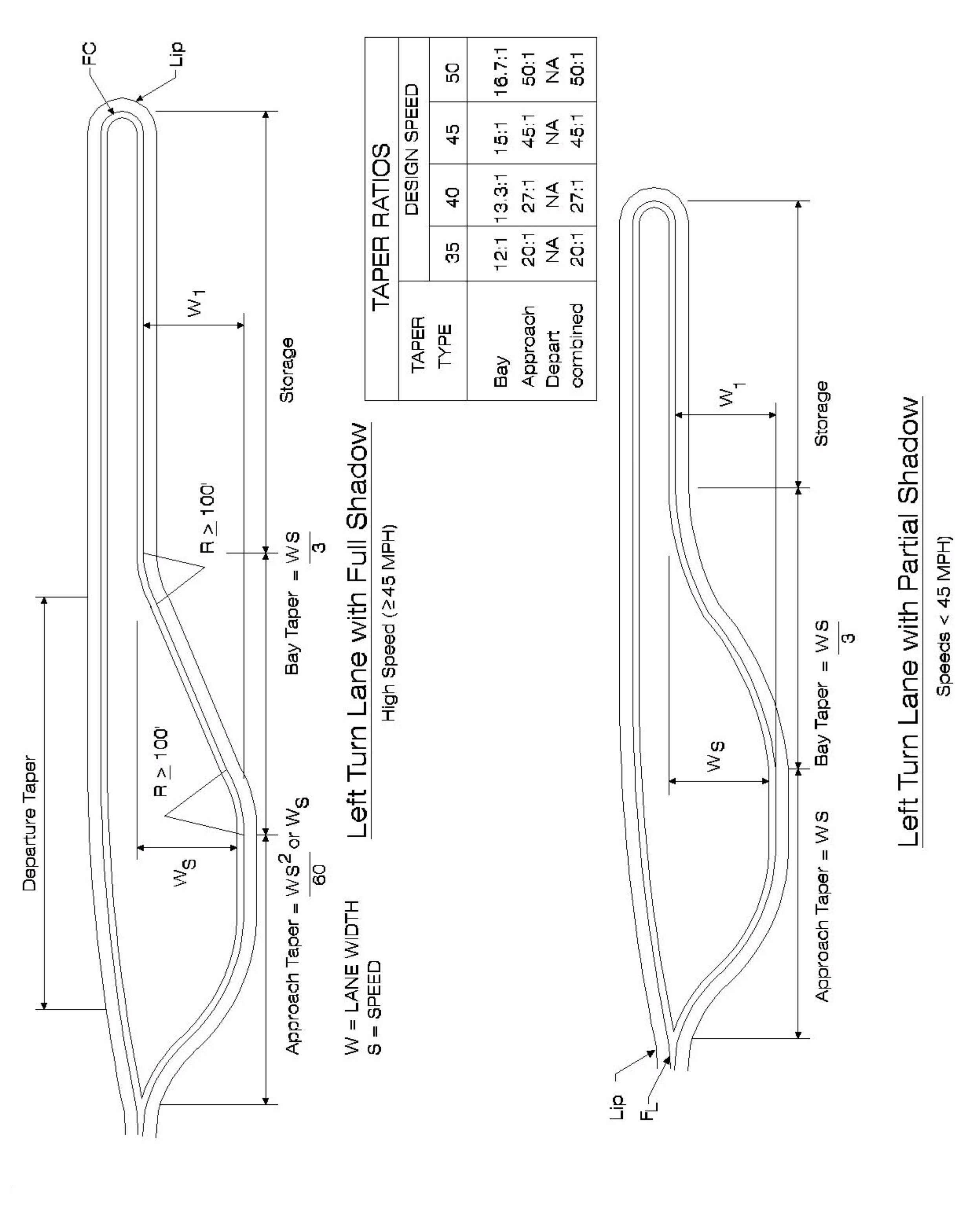
(b) At Unsignalized Intersections: Left turn lanes may be required at approaches to intersections for which the combination of through, left, and opposing volumes exceeds warrants as stated in a traffic analysis**.** The City Engineer will determine which peak hours to consider in this evaluation. The traffic impact analysis (TIA) shall make recommendations for the location and dimensions of all left turn lanes.

(c) Design Criteria: Left turn lanes shall be designed to provide the following functions:

i. A means for safe deceleration outside the high speed through lane.
ii. A storage length long enough for left turning vehicles so that signal phasing can be optimized and intersection delay minimized.
iii. A means of separating movements at unsignalized intersections to reduce left turn impacts on other flows.

The design elements for a left turn lane are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper. For a graphical representation of bay taper and approach taper lengths, see **Figure 3.3.13(8)c**. The required left turn lane widths shall be as specified in **Table 3.3A**. Other dimensions shall be as defined in the traffic impact analysis (TIA).

FIGURE 3.3.13(8)c LEFT TURN LANE DESIGN ELEMENTS



TAPER RATIOS				
TAPER TYPE	DESIGN SPEED			
	35	40	45	50
Bay	12:1	13.3:1	15:1	16.7:1
Approach	20:1	27:1	45:1	50:1
Depart	NA	NA	NA	NA
combined	20:1	27:1	45:1	50:1

Left Turn Lane Design Elements
Figure 3.3.13(8)c

(9) Exclusive Right Turn Lanes
Exclusive right turn lanes shall be provided at locations where they are specified as needed by an access plan, or where required by the applicable traffic impact study, approved by the City Engineer.

(a) Warrants for Right Turn Lanes: The traffic impact analysis (TIA) shall determine whether a right turn lane is to be provided at intersections or accesses. The designer should also refer to the Right Turn Lane Warrants section of the FHWA *Intersection Diagnostic Review Model* for guidance.

(b) Design Criteria: Right turn lanes shall be designed to accomplish the following functions:

i. Provide a means of safe deceleration outside the high speed through lane.
ii. Provide a separate storage area for right turns to assist in the optimization of traffic signal phasing.
iii. Provide a means of separating right turn movements at stop controlled intersections.

The design elements are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper. For approach taper lengths and other elements, see **Figure 3.3.13(9)a.**

Pedestrian Refuge

(c) Pedestrian Refuge: Where pedestrian refuge is required between a right turn lane and through lanes, it should be designed in accordance with **Figures 3.3.13(9)c and 3.3.13(9)d.**

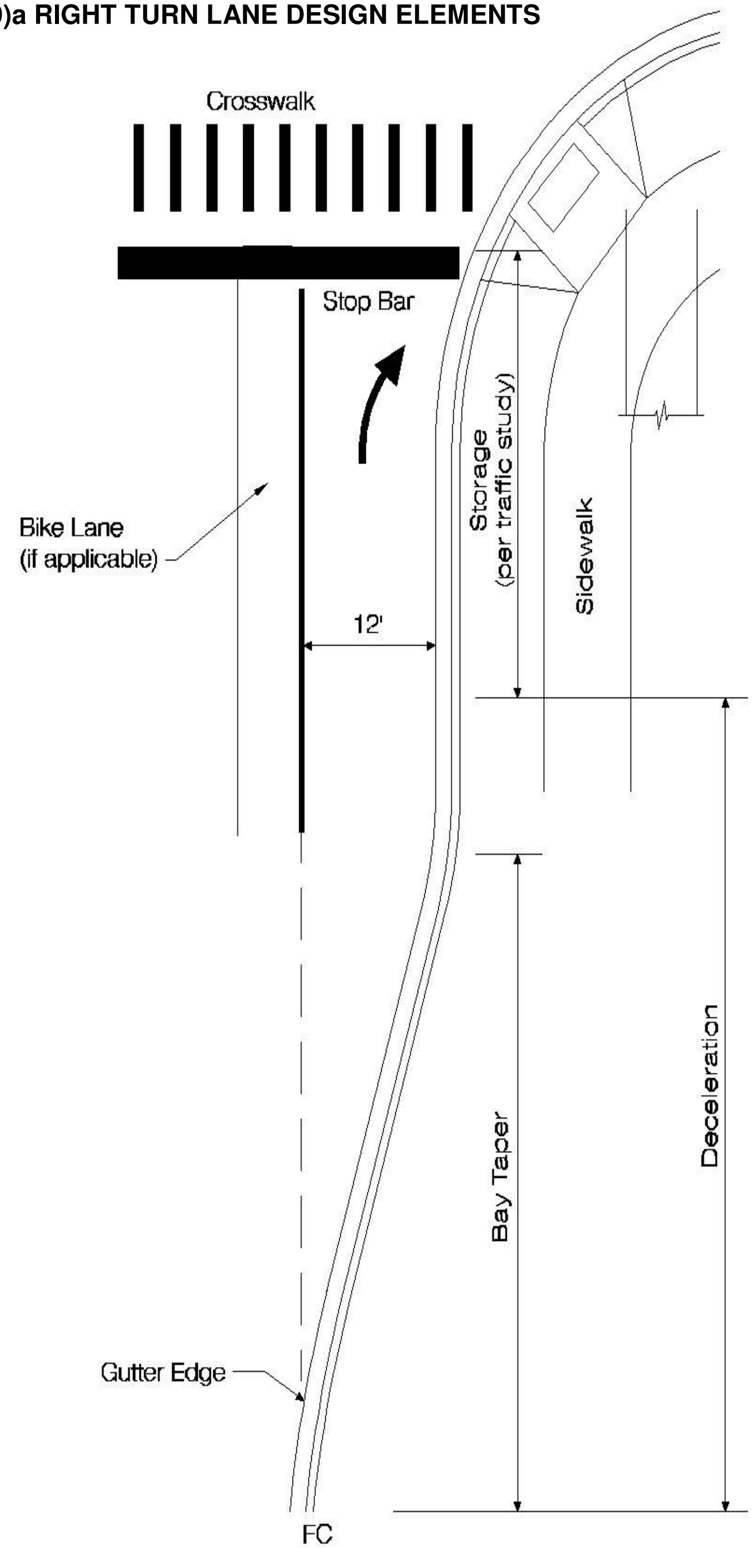
(10) Acceleration/Deceleration Lanes
For each high volume driveway and major intersection, acceleration/ deceleration lanes shall be considered. The specific designs for these lanes shall be in accordance with the design for left and right turn lanes given above. *NCHRP Report 279* should also be consulted during the design process for additional guidance.

(a) Acceleration Lane Transition Tapers: The traffic impact analysis (TIA) shall determine the necessary distances for designing acceleration lane lengths and tapers, subject to approval of the City Engineer.

(b) Deceleration Lane Transition Tapers: The traffic impact analysis (TIA) shall determine the necessary distances for designing deceleration lane lengths and tapers, subject to approval of the City Engineer.

(c) Left Turn Approach and Bay Tapers: When left turn lanes are designed with lateral transitions, the formula on **Figure 3.3.13(8)c** shall be used to compute the necessary distances, subject to approval of
the City Engineer.
(d) Right Turn Approach and Bay Tapers: When right turn lanes are designed with lateral transitions, the approach and bay taper formulas on **Figure 3.3.13(8)c** shall be used to compute the necessary distances, subject to approval of the City Engineer.

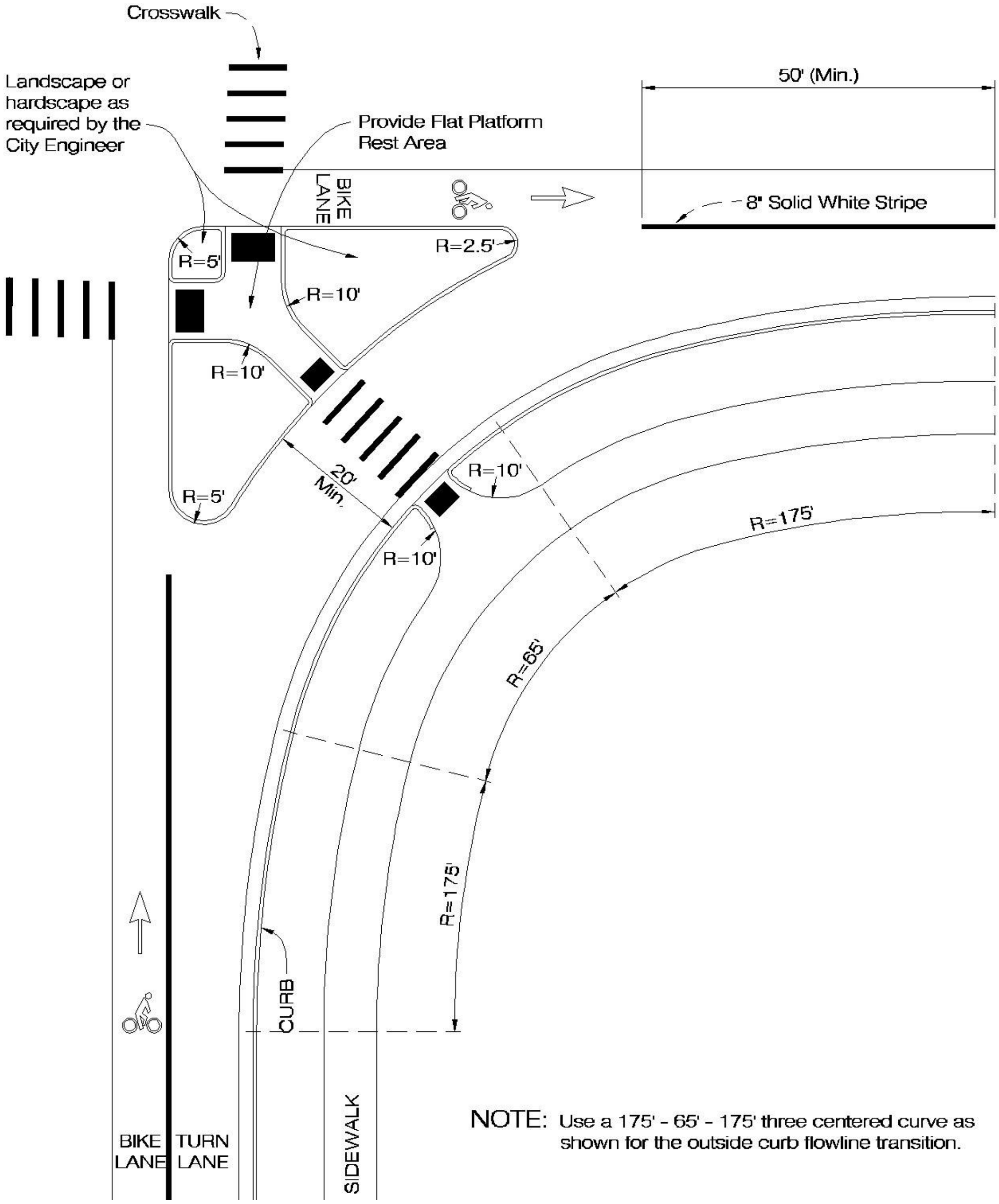
FIGURE 3.3.13(9)a RIGHT TURN LANE DESIGN ELEMENTS



NOTE: 1) Provide a 50'± arc length at angle points for a smooth curve.

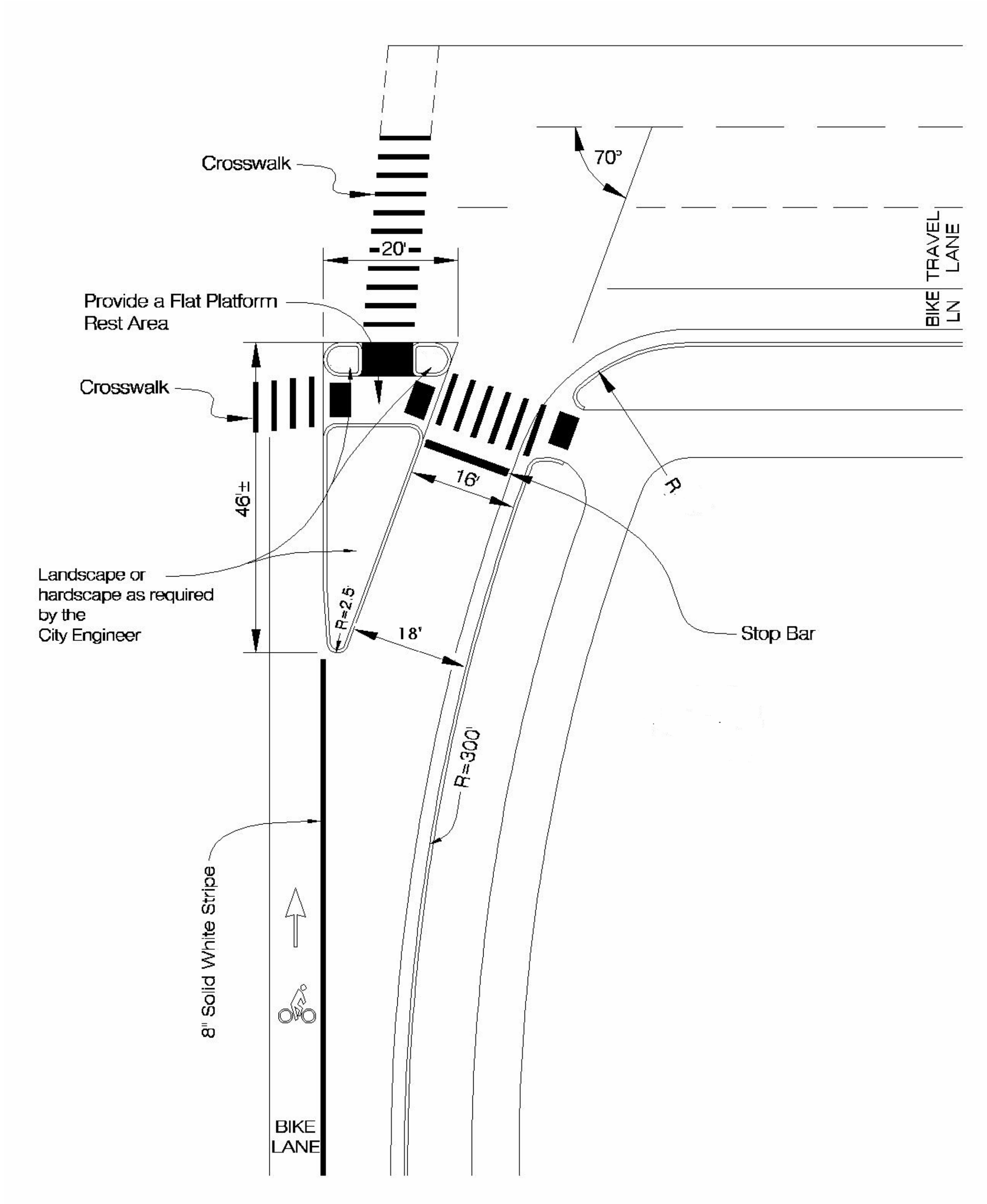
Right Turn Lane Design Elements
Figure 3.3.13(9)a

FIGURE 3.3.13(9)c PEDESTRIAN REFUGE ISLAND DESIGN WITH CONTINUOUS RIGHT TURN



Pedestrian Refuge Island Design with Continuous Right Turn
Figure 3.3.13(9)c

FIGURE 3.3.13(9)d PEDESTRIAN REFUGE ISLAND WITH RIGHT TURN LANE



Pedestrian Refuge Island with Right Turn Lane
Figure 3.3.13(9)d

(11) Curb Returns

(a) Radii of Curb Returns: The corner radii at street intersections shall meet the following minimum requirements in **Table 3.3.13(11)a** unless otherwise approved or required by the City Engineer. For curb returns on a State Highway, TDOT's curb radii requirements shall supersede these requirements. At street intersections in residential areas, the minimum radius of curb return shall be twenty-five (25) feet. In industrial and commercial areas, and when a residential street intersects with a non-residential street, the minimum curb return radius shall be thirty (30) feet. Should the expected right-turning truck volumes exceed ten (10) vehicles per hour in the design hour, then the designer shall use larger radii or 3-centered compound curves to provide for the turning movements of the larger vehicles. Where the angle of the street intersection is less than ninety (90) degrees, the City Engineer may require greater radii. See **Table 3.3.3** for general requirements regarding vehicle turning needs at intersections.

Table 3.3.13(11a) – Street Intersection Radius Returns

Classification	Intersecting with a:						
	Major Arterial	Minor Arterial	Major Collector	Minor Collector	Commercial Local	Industrial Local	Residential Local
On Major Arterials	Independently designed – 30 ft minimum						
On Minor Arterials	30	30	30	30	30	30	25
On Major Collectors	30	30	30	30	30	30	25
On Minor Collectors	30	30	30	30	30	30	25
On Commercial Locals	25	30	30	30	30	30	25
On Industrial Locals	Independently designed – 25 ft minimum						
On Residential Locals	25	25	25	25	25	25	25

(b) Curb Return Grades: The desirable grade for gutter flow-lines around the curb return should be a minimum of one (1) percent. The minimum allowable grade for gutter flow-lines around curb returns shall be a minimum of one-half (0.5) percent. Refer to Table 3.3.3.

(12) Traffic Islands

(a) Corner Islands Separating Right Turns: Standard corner islands shall be used in four (4) or six (6) lane Arterial/Arterial intersections to channelize traffic where required to provide pedestrian refuge or where required by the City Engineer. The corner islands shall be designed as raised islands in accordance with **Figure 3.3.13(9)c, or Figure 3.3.13(9)d,** for a right turn lane continuing to an exclusive lane or for a right turn lane stop or yield condition, respectively. The striping shall be in accordance with the requirements of the Traffic Control Section.

Typical Raised Median

(b) Median Islands Separating Opposing Traffic:
Median islands are required at all Arterial/Arterial intersections. If raised medians are not required by these Specifications, the median islands may be raised or painted. The length of the island shall include the appropriate approach taper, bay taper and length of lane required by the Specifications, or supported by another approved resource standard. The design shall be as follows:

i. No Obstruction. Medians must not obstruct the minimum left turn radius for the design vehicle(s).

ii. Drainage. Landscaped medians shall include drainage facilities to handle sprinkler run-off and nuisance flows. When low maintenance landscaping is used in conjunction with trickle irrigation, drainage requirements may be waived and outfall curb and gutter should be used.
iii. Median Islands Required. Median islands are standard on all new 6-lane and 4-lane Arterial streets. These islands shall be designed to provide pedestrian refuge.

(c) Median Islands on Minor Arterials, Collectors, or Local Streets: Raised medians may be placed in Minor Arterial, Collector, and all Local streets. If medians are included, they shall be placed in the public right-of-way, and they must meet the following standards for design:

i. No Obstruction. The medians may not obstruct the design vehicle turns.
ii. Visibility. The medians must be placed such that the required visibility in the intersection is not obstructed.
iii. Undiminished Use. Medians must be placed so they do not diminish the intersection use except where designing a right-in/right-out intersection.
iv. Alignment. Lanes on one side of the intersection must align with the correct lanes on the opposite side of the intersection.
v. Median Maintenance. Most medians will be maintained by parties other than the City. The maintenance responsibility must be defined on the Final Plat or Development Agreement. The City will maintain selected medians, primarily along State highways based on agreements with TDOT.
vi. Public Use. The City may use these islands for street signing and may choose to remove the medians if it is deemed necessary by the City Engineer.
vii. Additional Right-of-way. The Developer shall dedicate all additional right-of-way necessary to include these medians.
viii. Compliance with these Standards. The median design must comply with all applicable median criteria in these Standards and the streetscape standards of the City.

(d) Turn Prohibition Islands: An intersection may be designed with islands to prohibit left and right turn movements into or out of the intersection. Typically, these islands should not be used unless there is also a street median present to ensure that improper movements are not made.

Turn Prohibition Island

e) Splitter Islands on Roundabouts: In modern roundabout designs, raised splitter islands shall be designed in accordance with the Federal Highway Administration *Roundabouts: An Informational Guide* to direct traffic and provide pedestrian refuge.

(13) Right-of-Way
All intersection rights-of-way and utility easements shall be dedicated to provide adequate right-of-way to include sidewalks, access ramps, and utilities. Additional right-of-way may be required at intersections to provide space for additional left or right turn lanes without reducing the widths of standard required facilities. Where standard intersections are used, additional right-of-way may be required to accommodate the potential installation of a roundabout in the future.

(14) Channelization
Channelization refers to physical or visual guides used to separate vehicles, bicycles and pedestrians into particular lanes.

(a) Intent of Channelization:
Channelization is intended to:

i. Prohibit undesirable or wrong way movements.
ii. Define desirable vehicular paths.
iii. Encourage safe vehicle speeds.
iv. Separate points of conflict wherever possible.
v. Cause traffic streams to cross at right angles and merge at flat angles.
vi. Facilitate high-priority traffic movements.
vii. Facilitate traffic control scheme.
viii. Remove decelerating, stopped, or slow vehicles from high-speed through-traffic streams.
ix. Provide safe crossings for pedestrians/bicycles.
x. Provide safe refuge for pedestrians.

Channelization at intersection

(b) Specific Channelization Requirements: Channelization shall be required at locations where it is necessary for safety or to protect the operation of the major street. Examples include:

i. Providing raised medians in all Arterials where left turns are prohibited.
ii. Prohibiting undesirable turning movements such as right and left turns, in and/or out.
iii. Providing exclusive turning lanes, with appropriate striping.
iv. Providing travel lanes, with widths as specified in the standard street cross sections.
v. Raised islands must be large enough to be visible to vehicle drivers. Therefore, no single island, including pedestrian paths and/or pedestrian refuge, shall be smaller than 100 square feet.

(15) Street Narrowing
Minor Collector or Local streets may be narrowed at intersections to provide more visibility for pedestrians. This shortens the distance necessary for pedestrians to cross the street. The narrowing shall not encroach into bike lanes or travel lanes. Narrowing may not be used on Major Collectors without any parking lanes, on any Arterials, or where the standard width is necessary. When narrowing is proposed, turning paths shall be evaluated to ensure that anticipated service vehicles (fire, sanitation, school buses) can be accommodated with the proposed design.

(16) Roundabouts
Roundabouts are considered a form of traffic control. Roundabouts shall be considered as two types: (1) Modern Roundabouts and (2) Mini Roundabouts.

(a) Modern Roundabouts: Modern Roundabouts shall be specially designed to the specific need on high traffic volume streets and used to improve traffic flow. Refer to *Federal Highway Administration, Roundabouts: An Informational Guide* for typical layout. The following are certain minimum requirements:

i. Design Vehicle. Modern roundabouts shall be designed to accommodate WB-67 trucks at state route intersections. A WB-50 truck is allowed for collector street intersections.

ii. Central Island Radius. The central island radius shall be determined by the Designer and approved by the City Engineer.

iii. Street Width. The circulatory street width shall be a minimum of 1.2 times the width of the widest entering street. This width may include the apron when approved by the City Engineer. Concrete truck aprons with a minimum width of eight (8) feet should be provided on the perimeter of the central island.

iv. Where Allowed. Roundabouts may be allowed on any street as approved by the City Engineer.

v. Design Experience. The design shall be performed or checked by a registered Professional Engineer who has designed a minimum of two roundabouts that are currently in operation. These two designs shall have a documented constructed capacity that meets or exceeds the twenty (20) year projected intersection volume.

vi. Purpose. The roundabout is a traffic control device in lieu of a multi-way stop or a traffic signal. Roundabouts assist in improving the performance of intersections that have the following characteristics:

- High number of accidents;
- High delays;
- Four (4) legs or more or usual geometry;
- Frequent U-turns; and
- High left-turn movements.

vii. Design Software. The roundabout design shall be completed with the aid of computer software. Acceptable products include the latest versions of ARCADY or RODEL. The specific application of the product must be approved on a case-by-case basis by the City Engineer. The City Engineer is authorized to require the use of a specific software package when warranted by the needs of a specific intersection.

viii. Right-of-way. The City will require additional right-of-way to be dedicated by the Developer to accommodate the roundabout.

ix. Splitter Islands. Raised splitter islands shall be required on all approaches. All objects in the island shall be of a yielding design.

x. Signing. The signing shall be in accordance with the Traffic Signs and Markings section and the latest edition of the MUTCD.

(b) Mini Roundabouts: Mini Roundabouts may be allowed in a neighborhood setting for traffic calming.

i. Where Allowed. Mini roundabouts may be used on Local Streets and Minor Collectors.

ii. Design Basis. The design shall be performed in accordance with the FHWA *Roundabout Design Guide*, or other design criteria approved by the City Engineer.

iii. Street Width. The circular street shall be a minimum of twenty (20) feet wide flow-line to flow-line, and the approach legs shall be sixteen (16) feet wide minimum.

iv. Truck Aprons. Design specifications to be approved by City Engineer.

v. Design Vehicle. Mini roundabouts shall be designed to accommodate WB-50 vehicles. Encroachment onto the truck apron and adjoining sidewalks may be approved by the City Engineer.

3.3.14 Public Sidewalks, Curbs & Gutters, Shoulders and Ditches

(1) Sidewalks

(a) Typical Cross-Sections: Street cross sections that include sidewalks shall be as specified in this chapter. The typical cross-sections are provided at the end of this chapter**.**

(b) Clear Zone: Sidewalks shall be designed to provide a desirable lateral clear zone of two (2) feet, with an absolute minimum of one (1) foot clearance. Vertical clearance should be at seven (7) feet or higher.

Typical Sidewalk with Grass Strip

(c) Other Sidewalk Requirements: Refer to **Section 3.4, Pedestrian Facilities**, for other related sidewalk requirements and guidance from the City's *Bicycle and Pedestrian Plan*.

(d) Location of Sidewalks: Sidewalks are required on both sides of all streets in the City except Mack Hatcher Parkway, Interstate 65, rural roads, alleys, and the undeveloped edge of neighborhood parkways. Sidewalk design shall comply with the standards in this section.

(e) Setback: Sidewalks shall be set back a minimum of five (5) feet behind the street curb along lots within conventional areas. The intervening space between the back of the curb and the edge of the sidewalk is intended for the placement of street trees and other roadside features.

In areas designated as "traditional", sidewalks shall normally be set back a minimum of five (5) feet behind the street curb. The intervening space between the back of the curb and the edge of the sidewalk is intended for the placement of street trees and utilities. Along nonresidential and mixed-use lots within traditional areas, sidewalks may be located at the back of the curb. In no instance shall the intervening space between the back of the curb and the façade of a building be less than ten (10) feet.

(f) Minimum Width: Sidewalks running along streets shall meet the following minimum width standards:

i. In no instance shall a sidewalk located within a public street right-of-way have a minimum width less than five (5) feet.

ii. Sidewalks abutting a nonresidential or mixed-use structure shall have a minimum width of eight (8) feet.

iii. Sidewalks designed as multiuse paths shall have a minimum width of twelve (12) feet.

(g) Ramps: Ramps meeting requirements of the Americans with Disabilities Act (ADA) shall be installed at the intersection of all sidewalks with public streets. Ramps shall be designed in accordance with the Standard Drawings**.** Also see ADA standards from the North Carolina Accessibility Code, Vol. 1c, for additional design guidance.

(h) Configuration

i. Sidewalks shall be constructed of concrete, textured pavers or a combination of these materials, and shall be raised above the adjacent street level. In special circumstances, brick sidewalks may be allowed by the City Engineer, provided that an agreement is executed requiring maintenance by others.

ii. Pedestrian street crossings at intersections may be raised above the adjacent street level as a traffic-calming measure.

iii. Sidewalks shall connect with existing or planned sidewalks at property boundaries.

iv. Sidewalks shall connect building entries within and between developments.

v. Except where brick or pavers are used, all public sidewalks shall maintain a brushed concrete finish for safety.

(i) Inlets: Drainage inlet accesses located in a sidewalk shall be integrated with sidewalks. The inlet access shall be flush with the sidewalk surface. No manholes, inlets, or other storm sewer facilities are allowed within curb ramps. Refer to the drainage study requirements for sizing of inlets. Inlets are not allowed in the curb return, but shall be located at or behind the tangent points of the curb returns.

(j) Payment In-Lieu of Sidewalks: The payment of fees, in lieu of installing a required public sidewalk may occur at the request of the developer with approval of the City Engineer, upon finding that:

i. The street is designated as a state highway subject to widening/improvement in the foreseeable future;
ii. The street is planned for improvement per the Major Thoroughfare Plan or Streetscape Plan;
iii. Alternate on-site pedestrian facilities, such as trails, greenway, or multiuse paths, are adequate; or
iv. The right-of-way, developing lot, or lot abutting a proposed sidewalk is not suitable for sidewalks due to floodplains, wetlands, HHO Districts, riparian buffers, required tree canopy retention areas, slopes exceeding 14 percent, or other unique site conditions. The procedure and process for approval shall be as outlined in section 5.10.13 of the Zoning Ordinance.

(2) Curb and Gutter

(a) Type and Location: Table 3.3A notes the type of curb and gutter to be used for the various street classifications and sections.

(b) Vertical Curb and Gutter: The vertical curb or curb and gutter section shall be in accordance with the Standard Drawings. All new streets shall be constructed using vertical curb and gutter except for the Residential Local Street where Mountable Drive-Over curb and gutter may be used.

(c) Mountable Curbs: Mountable combination curb, gutter, and walk is permitted on Local Streets only.

(d) Median Islands: All median islands shall be designed with curb and gutter as shown in the Standard Drawings**.**

(f) Ribbon Gutters: Ribbon gutters will only be approved by the City Engineer in special circumstances.

Standard Curb and Gutter section

Standard Mountable Curb and Gutter section

(3) Shoulders

All streets constructed in the City should be constructed with curb and gutter. However, in extenuating circumstances, shoulders may be allowed by the City Engineer on a case by case interim basis. Where authorized, they shall be provided in addition to the elements shown on the typical cross sections contained at the end of this chapter.

(4) Roadside Ditches

(a) Location: Ditches are not normally allowed in the City. Where the City Engineer approves interim street sections developed without curbs (and with roadside drainage ditches), the design must complete the ditch construction with the installation of sod or other approved erosion control blanket within the ditch area.

(b) Ditch Profile: The profile grade of the ditch shall be maintained at a minimum slope of one (1.0) percent and a maximum slope of five (5.0) percent. The side slopes of the ditches outside of the right-of-way shall be a minimum of 3:1 and meet any specific criteria of the drainage study. Flatter slopes may be considered when a paved invert is designed for the ditch bottom.

(c) Ditch Slope: The slope and capacity of any roadside ditches shall be maintained in any areas that driveways cross the ditch. Each site is required to provide a concrete pipe, a minimum of fifteen (15) inches in diameter, calculated to meet capacity and strength requirements of the drainage study. The pipe shall be designed to have no less than twelve (12) inches of cover over the pipe. All portions of the driveway within the right-of-way shall be paved with concrete or asphalt.

(d) Ditch Maintenance: All driveway improvements within the right-of-way including piping, ditches, curb and gutter, and sidewalk are generally the responsibility of the City.

3.3.15 Medians

(1) General Requirements

General criteria for medians are specified in **Table 3.3A**. Also refer to the Franklin Zoning Ordinance. In the City, medians are required on all Arterial Streets. Raised medians are preferred, but depressed or painted medians may be allowed on a case by case basis. Other medians may be required by the City Engineer for specific circumstances to control traffic. Medians requested by developers may be approved as long as additional rights-of-way are dedicated and all maintenance shall be done by viable private parties .The minimum width of any raised median shall be four (4) feet wide, from face-of-curb to face-of-curb.

Typical Street Median

(2) Turn Lane and Access

The design of medians shall include the evaluation for current and future turn lanes and accesses. For the minimum requirements of turn lane design, see the **Intersection Section 3.3.13**.

(3) Design of Openings

Median openings shall be designed to accommodate the selected design vehicle for all movements. Raised island and other geometric design features shall be installed at median openings when necessary to prohibit certain turning or cross movements in the intersection.

Typical Median Opening

(4) Spacing of Openings

The effectiveness of medians is diminished by frequent and/or poorly spaced median openings. Openings should therefore be carefully coordinated with public and private street access points. Median openings should be located only at major public or private access points, or at mid-block locations if needed to serve U-turns. Optimum location of openings is best determined based on the findings of a Circulation Plan and Traffic Impact Analysis. Minimum spacing on major streets should normally be at least six-hundred (600) feet to accommodate back to back left turn lanes and weaving between openings.

(5) Drainage
Landscaped medians shall be provided with drainage facilities to handle sprinkler runoff and nuisance flows. Sprinklers shall be designed to prevent spray onto the pavement surface. A properly designed drain system shall be required.

(6) Curb and Gutter
If gutters are not needed to serve the drainage referenced above, medians may be constructed with outfall curb and gutters. Post curbs are not generally allowed in the City although they may be approved by the City Engineer for use with medians where surface water is not collected or channeled.

(7) Nose Design
Vehicle tracking templates shall be used to determine the optimum position and design of the median nose so that vehicles do not track onto the median, and are coordinated with other movements in the intersection. The minimum radius for nose curbs shall be two (2) feet to flow-line.

(8) Paving
When medians are not landscaped, they shall be paved with stamped, colored, or broom finished concrete in accordance with the City's streetscape standards.

(9) Transitions
The ends of medians shall transition into turn lanes with a minimum radius of one-hundred (100) feet. Change in curb directions must be accomplished with the use of radii. Angle points shall not be allowed.

(10) Objects
No permanent structures, including light poles, fire hydrants, trees, walls or other fixed objects in the median should be placed within five (5) feet of the edge of the travel lane, or in any location that would obstruct sight distance except for structures as approved in these Standards. If a median streetlight is placed within five (5) feet of the travel lane, the light should be an approved breakaway design.

3.3.16 On Street Parking

(1) General
This chapter defines the parking criteria for on-street parking, including Downtown parking, parking on cul-de-sacs, and other special areas. Parking may be allowed on Local and Minor Collector streets at the discretion of the City Engineer. Parking shall not be allowed on Major Collector and Arterial streets.

(2) Parallel Parking
Parallel parking is permitted on certain streets as approved by the City Engineer.

(3) No Parking Signs
For all streets in which parking is limited or not allowed, "No Parking" street signs may be required as a part of the street design.

(4) Non-Parallel Parking
In Downtown areas and other special designation areas, the City may permit perpendicular or diagonal parking. The City Engineer must specifically approve any on-street parking areas that are not designed as parallel parking. All areas approved for diagonal parking shall be designed at an angle of thirty, forty-five, or sixty degrees, as approved by the City Engineer.

(5) Parking in Cul-de-Sacs
Parking in cul-de-sacs is only allowed where the design will accommodate emergency vehicle operations with on-street parking. Where a center island has been approved for installation by the City Engineer, on-street parking may be prohibited unless it can be shown that parked vehicles will not hinder emergency or routine service vehicles.

(6) On-Street Handicapped Parking Requirements
Streets within commercial areas may be required by the City Engineer to provide on-street spaces specifically designated for handicapped parking. Such parking shall not be designed as parallel parking due to its expanded width requirements.

(7) Inset Parking
Parking inset from the curb line may be allowed by the City subject to the approval of the City Engineer. In these cases, additional right-of-way will likely be required to provide the roadside features shown on the typical cross sections.

Typical Inset Parking

(8) Driveway Clearance
A vehicular parking space within the street shall be designed with a minimum clearance of six (6) feet from the edge of a driveway.

(9) Intersection Clearance
A vehicular parking space in the street shall be designed with a minimum clearance of thirty-five (35) feet from the intersection flow-line. Depending on traffic conditions, the City Engineer may require a greater clearance.

3.3.17 Drainage

(1) General
Streets are not to be designed as conveyance systems for surface water. However, all streets must be so designed as to provide for the discharge of surface water from the right-of-way of the streets by grading and drainage as shall be approved by the Street Department Director and the City Engineer. Hydraulic capacities and locations of drainage structures in the public street right-of-way should be designed to take into consideration upstream and downstream properties and to secure as low a degree of risk of traffic interruption by flooding as is consistent with the importance of the street being designed.

(2) Drainage Inlets
Drainage inlets should be designed and located to limit the spread of water on the traveled way to no more than one half of the travel lane width. Bike lanes and shoulders may be used full width for spread. Because grates may become blocked by trash accumulation, curb openings or combination inlets with both grate and curb openings are advantageous for City streets. These inlets and grates should be located outside the travel lanes to minimize shifting of vehicles attempting to avoid them. Inlet grates shall also be designed to accommodate bicycle and pedestrian traffic where appropriate.

(3) Storm Sewers
Where water cannot be adequately discharged by surface drainage, storm sewers shall be required. Public streets are not to be used to collect and convey storm water runoff other than that which falls on a lot fronting that street. In addition, the street and drainage design shall be such that storm water runoff shall not be allowed to flow across street intersections.

(4) Construction Standards and Specifications
Construction standards and specifications for storm drainage in City streets are contained in the City's *Storm Water Management Manual*. Some specific drainage design requirements relating to the design of streets, however, are as follows:

(a) A street shall not carry storm water runoff for a distance greater than four-hundred (400) feet from the beginning point of the runoff.

(b) Discharge from the street shall be handled by means of a catch basin/curb inlet; the number, size, and location to be determined by the Engineer as approved by the City Engineer. The type of catch basin/curb inlet shall be the City's standard for the particular application.

(c) Culverts (pipe) within the street right-of-way shall be reinforced concrete pipe (RCP) as per ASTM C76, Table III or Table IV, with a minimum inside diameter of fifteen (15) inches.

(d) Catch basins/curb inlets at low points along the streets and at the end of cul-de-sacs are to be as a minimum double inlet catch basins/curb inlets. Grate inlets should be moved to curb and gutter when adding turn lanes. The grate should be replaced with a manhole lid for any structure remaining in the turn lane.

3.3.18 Bridges

(1) Lane and Sidewalk Widths
The width of street travel lanes and sidewalks across bridge structures shall be equal to the widths on the street approaching the structure. Sidewalk and lane widths shall not be reduced from approach dimensions when crossing a bridge structure. Grass strip width may be eliminated across the bridge.

(2) Rails
All bridge rail or safety barriers shall concrete or metal beam guardrail constructed in accordance with approved TDOT standard drawings as approved by the City Engineer. Bridge rails shall incorporate aesthetic features such as formliners or stone veneers where approved by the City Engineer.

(3) Approach End Treatments
All approach end treatments for bridge rails shall be required at each end and shall be in accordance with TDOT standard drawings as approved by the City Engineer.

3.3.19 Clearance Requirements

(1) General
Streets should be designed to minimize the potential for traffic accidents involving fixed objects beside the street travel way. The street designer should consult the latest edition of the AASHTO *Roadside Design Guide* to design the safest possible roadside along City streets.

(2) Horizontal Clearance to Obstructions
The *Roadside Design Guide* should be consulted in the design process to identify the suggested clear zone dimensions and/or barrier for the street being designed. Regardless of this guidance, the desirable minimum lateral clearance from the face of curb to the nearest edge of an object is two (2) feet.

(3) Vertical Clearance
The minimum vertical clearance above a street is fourteen feet and three inches. On designated truck routes, this minimum clearance is sixteen feet and six inches.

(4) Guardrails
The type and location of guardrails used in the City shall be approved by the City Engineer on a case-by-case basis.

3.3.20 Barriers and Fencing

(1) Roadside Barriers
All safety barriers shall be TDOT approved crash-tested barriers. Aesthetic treatments such as stone veneer, concrete with a formliner finish, or painted railings may be used with the approval of the City Engineer.

Bridge Rail Barrier

(2) Median Barriers
All median divider barriers shall be TDOT approved, crash-tested barriers walls. Glare screens may be required for high volume streets as approved by the City Engineer.

(3) Fencing
No fencing shall be installed in the street right-of-way. Fencing installed behind the right-of-way shall not result in sight distance less than the recommended distances in this document.

Access Fencing

(4) Maintain Sight Distance
No fencing or barrier installed in or adjacent to the street right-of-way shall result in sight distance less than the recommended distances in this document.

3.3.21 Provision for Utilities

This section sets forth the criteria and location requirements for all utilities located within the right-of-way and/or public utility easements located adjacent to public rights-of-way, such as: water, sewer, storm sewer, subdrains, power (electric and natural gas), phone, cable television (CATV), traffic signals and mailboxes. The appropriate utility department or agency shall determine all final alignments of utilities in consultation with the City Engineer. For new and widened streets, provisions shall be made to include conduit for future signal interconnects and all required pullboxes.

(1) General Requirements
Standard plan requirements and layout requirements are discussed in earlier sections. Refer to **Figure 3.3.21(1)** for general utility placement guidelines.

(2) Minimum Depth
All utilities shall be located at least two (2) feet below the subgrade elevation, unless specifically approved to be less by the City Engineer. Greater depth of cover may be specified by the City Engineer.

(3) Access Covers

(a) Clearance: All manhole lids, utility access covers, and range box access covers shall be flush with the street finished surface. If located in concrete drives or sidewalks, all access covers shall be set flush with surrounding concrete.

(b) Wheel Path: Manholes or valves installed in the street travel way shall not be designed or constructed in the wheel path of the travel lane or at any location within a bike lane.

(4) Trees and Large Shrubs

(a) Buried Utilities: Trees, berms or large shrubs shall not be placed directly over buried utilities in the public right-of-way or easement. Additional horizontal clearances from the trunk of any tree or shrub to any buried utility may be required by the respective utility department or agency, as required for access, repair and/or maintenance activities.

(b) Overhead Utilities: Trees should not be planted under overhead power lines when mature growth of the tree would encroach within the influence areas of the power lines.

(5) Use of PVC Sleeves by Franchised and Private Utilities

(a) General: It is the intent of these standards to reduce the amount of open cuts in the street. Therefore, franchised and private utility companies shall install all utilities within a non-corrosive sleeve equivalent to Schedule 80 PVC or other sleeves encased in concrete, slurry or flowable fill material, across all public streets to accommodate future repairs without street cuts.

(b) Exceptions: Steel gas line street crossings will not require sleeves.

(c) Depth: Sleeves shall be installed at a minimum depth of forty-two (42) inches from the top of the pipe to the top of pavement or thirty-six (36) inches from the top of pipe to the top of subgrade, whichever is greater.

(d) Location: Unless otherwise approved by the City Engineer, all utility sleeves shall be located within fifteen (15) feet of the parallel gutter flow-line of the existing street and shall be coordinated with other utilities. Sleeves shall be separated for existing buried utilities in accordance with the utility owner requirements. Ten feet of separation is typically preferred.

(e) Street Cuts: Utility crossings of existing streets shall be performed in accordance with an approved Street Crossing Permit as issued by the City. Installations utilizing jacking or boring under the street is the primary methods. Open cuts must be justified for need.

(f) Potential Signalized Intersections: Refer to **Chapter 9, Signal Design**, for guidance on underground facilities for traffic signals.

(6) Location Criteria

(a) General: The utility locations discussed below are recommended for new development and preferred in the case of existing streets and established developments.

(b) Water Mains: Water mains should be located on the north and east sides of streets approximately seven (7) feet south or west of the north or east gutter flow-line. Water mains shall be separated by a minimum of ten (10) feet horizontally from sanitary sewer and storm sewer facilities. The vertical depth of the water lines shall meet the requirements of the appropriate utility department or agency.

(c) Fire Hydrants: Fire hydrants shall be located two (2) feet minimum from curb and gutter flow-line or two (2) feet minimum from back edge of a sidewalk or ten (10) feet minimum from edge of pavement if no curb is present. In addition, the water line shall be located such that the valves will not be in the wheel path of the street lane.

(d) Sanitary Sewer: Sanitary sewer should be on the centerline of the street pavement. If a median is present, the sanitary sewer line shall be located six (6) feet west or south of the median. The sanitary sewer shall be located such that the manhole locations are not within the wheel path of the street lane. The vertical depth of the sanitary sewer lines shall meet the requirements of the sanitary sewer standards of the City.

(e) Storm Sewer: The storm sewer shall be placed so the manhole locations are not within the wheel path of the street lane. The storm sewer lines shall meet the requirements of the storm sewer standards as provided in this document.

(f) Natural Gas: Gas mains shall be located either within the right-of-way or in an adjacent easement on the south and west sides of the street. For double mains (a main on each side of the street), the requirement of north and east/south and west may be waived by the City Engineer.

(g) Power and Street Lighting: Generally, power and street lighting conduits shall be located on both sides of the street either within the right-of-way or in an adjacent easement. Double conduits (a conduit on each side of the street) may be acceptable as approved by the City Engineer.

(7) Other Systems

(a) Cable TV/Telephone: Cable TV and telephone lines generally serve properties from the back. For mains along the street front the utility shall coordinate the location in the right-of-way or easements with the City Engineer. All pedestal boxes, new and relocated, located in the right-of-way between the curb and the sidewalk shall be installed below ground.

(b) Mailboxes: Mailboxes should be installed a minimum of one and one-half (1.5) feet from the face of the curb, or travel lane. Mailboxes should not cause any sight obstruction for motorists exiting side streets or driveways. Mailbox supports should not pose a fixed object hazard for vehicles and pedestrians.

(c) Poles

i. Location: Poles, signs, and any other above ground streetscape (except regulatory signs) should be located within five (5) feet of the right-of-way line or ten (10) feet from the travel lane (flow-line), whichever is most restrictive.

ii. Clearance: Street light poles shall be placed no closer to the street than two (2) feet behind a vertical curb line and no closer than two (2) feet to any sidewalk.

iii. Pole Requirements: The City Engineer may require breakaway poles on public right-of-way where speed limit is 40 MPH or higher.

iv. Engineer Approval: All poles within the public right-of-way must be approved by the City Engineer prior to the permit application for installation.

v. Other Requirements: All signs and heights shall meet the requirements of **Chapter 9**, **Traffic Signs and Marking**.

(d) Subdrains: Subdrain main lines may be permitted within the public right-of-way. The Developer shall be required to provide additional information and soils investigation. In addition, subdrains shall be designed in accordance with the requirements of this document. If the soils investigation shows that subdrains are required for private property foundations, these lines may be designed to be installed within the public right-of-way only if all requirements of these Standards are met.

i. Private Property. Subdrains built within the right-of-way for private drainage shall be private improvements and shall have provisions for viable maintenance by the local homeowners association or other private entities. The City may require the private party to abandon or relocate such subdrains.

ii. Public Property. A subdrain is public if it is used to drain public improvements, such as the street/pavement section.

iii. Depth. Top of pipe shall be at least thirty-six (36) inches below pavement surface.

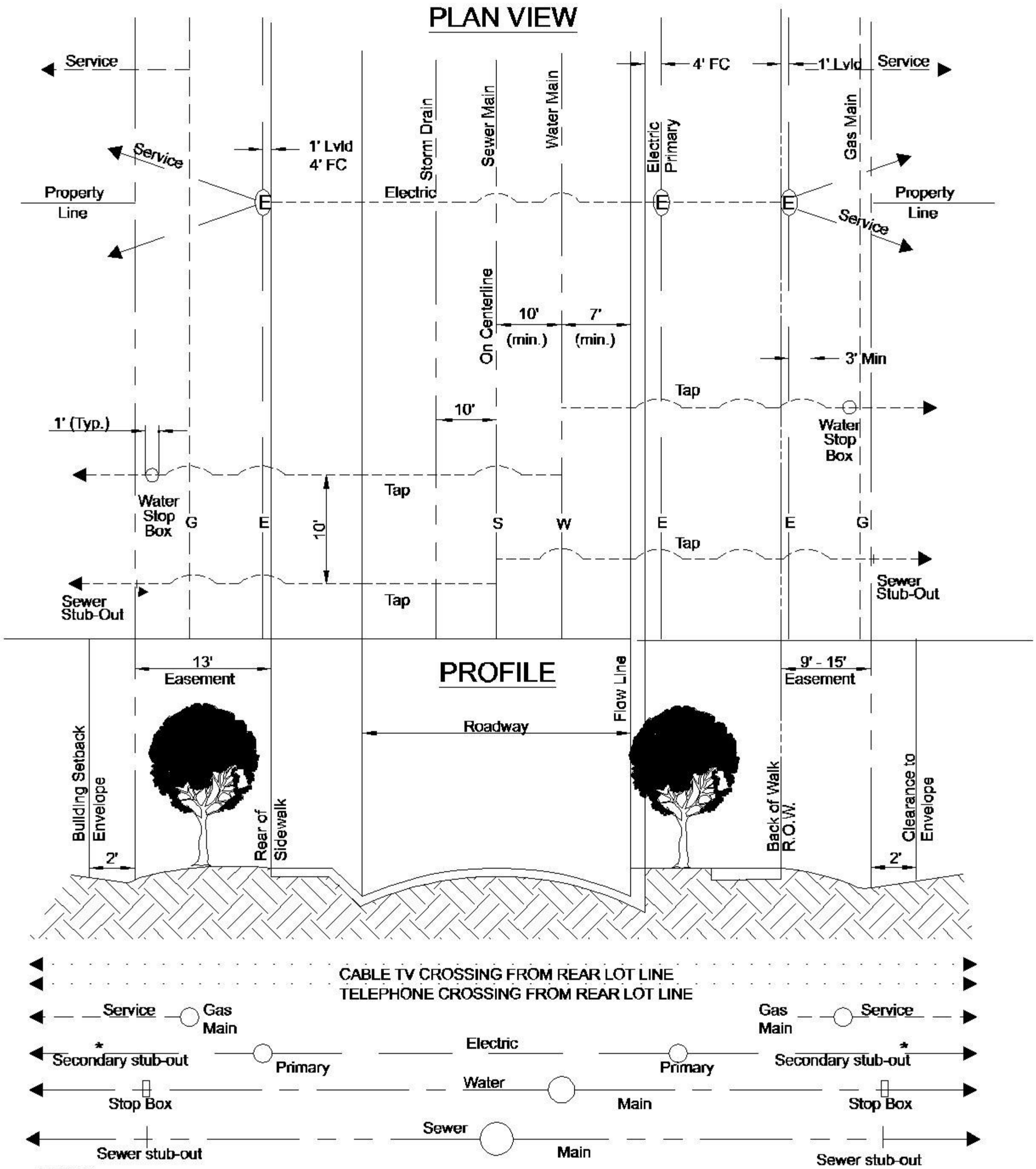
iv. Outlet. All subdrains shall outlet to a detention pond, inlet, or other approved location. Each outlet shall have a device to prohibit backflow into outlet pipe.

v. Perforated subdrains for private improvements shall not be allowed within any public right-of-way or easement.

vi. Professional Engineer. Subdrains must be designed by a Professional Engineer and are subject to approval of the City Engineer.

(8) Utility Crossings with Bridge Structures

Conduit sleeves may be required within the bridge structures to provide for electrical, gas, telephone, and cable crossings. The City Engineer may require additional sleeves to be designed with the bridge structure for sewer, water, or other utilities.



NOTES:

1. No scale to the drawing above. All measurements shown are minimums.
2. Storm and sanitary sewers, manholes, water valves or telephone manholes are not allowed in the wheel path.

Utility Location Guidelines
Figure 3.3.21(1)

3.3.22 Streetscape and Landscape Design

Street landscaping shall be installed such that it does not obstruct motorist sight distance as outlined earlier in this chapter. For all street landscaping standards, including median and parkway sections within the City, see the City of Franklin *Streetscape Design Standards and Guidelines.* All landscaped areas within the center islands or off-street areas shall be maintained by a private entity (i.e., Home Owner's Association). The City will not be responsible for their maintenance. Any proposed irrigation should be designed as a drip system to minimize water onto the pavement areas.

3.3.23 Emergency Access Street Requirements

Any emergency street access not on public right-of-way shall be provided in accordance with the Emergency Access Section in the City *Zoning Ordinance,* or in accordance with the requirements of the City Fire Marshall.

(1) Grade
The grade of the fire lanes shall be a minimum of one-half (0.5) percent and a maximum of eight (8.0) percent.

(2) Cross Slope
The Cross Slope of the fire lanes shall be a minimum of one (1.0) percent and a maximum of four (4.0) percent.

(3) Lane Width
The lane width shall be a minimum of twenty (20) feet from the edge of the street to edge of the street and shall be in an access Easement. The access easement shall have a minimum width of twenty (20) feet. The lane widths may be required to be increased through horizontal curves to accommodate fire truck passage.

(4) Vertical Clearance
There shall be a minimum of thirteen and one-half (13.5) feet of vertical clearance over the entire fire lane.

(5) Barricade
The fire lane may contain an approved barricade, but it must be of a type approved by the City Fire Marshall.

(6) Signs and Markings
The fire lane shall contain signs and markings as required by the City Fire Marshall.

(7) Street Surface
The surface of the street must be a paved surface complying with Local Street pavement thickness requirements, unless approved otherwise by the City Engineer.

(8) Maintenance
All access streets shall be maintained and kept clear for emergency use at all times.

3.3.24 Bus Stops

(1) General

The minimum design criteria for the location and construction of bus stops is as described below. The City Engineer may vary any of the following requirements as deemed appropriate for the site and its particular situation. The Designer shall propose and the City Engineer will approve the exact location of the bus stop in a proposed development. All bus bay locations

Trolley / Bus Stop

shall be coordinated with the City Engineer.
Bus stop locations may be required to be constructed with special pavement designs. Developments shall include a trolley shelter along streets served by trolleys at locations identified by the Transit Agency. A statement confirming the viability and availability of the site as a current and/or future trolley stop, and the appropriateness of the design of the shelter, shall be obtained from the agency. If the stop is deemed not viable, then the City Engineer may waive the trolley shelter requirement.

(2) Bus Lane Width
Bus bays should be at least ten (10) feet wide.

(3) Approach Leg (Near-side) Minimum Criteria
Bus stops on the approach leg of an intersection should be at least fifty (50) feet long for a single bus, plus a sixty (60) to eighty (80) foot transition distance kept clear approaching the stop.

(4) Departure Leg (Far-side) Minimum Criteria
Bus stops on the departure leg of an intersection should provide a fifty (50) foot long loading area plus forty (40) to sixty (60) feet of transition distance.

(5) Mid-Block Stops
Mid-block stops shall be designed with entrance and exit designed for the posted speed limit in accordance with transition criteria approved by the City Engineer.

(6) Bus Bays
All bus pullouts and bays required by the City shall be designed and constructed in accordance with AASHTO guidelines.

(7) Bus Shelters
For access and design guidelines for bus shelters required by the City, refer to AASHTO guidelines.

(8) Bus Pullout Lanes
Bus pullouts shall be constructed with no less than fifty (50) feet between an intersection curb return (point of curvature, P.C.) and the beginning of the lead-in taper.

3.3.25 Access Management & Design

(1) General
Driveway and street access to the public street system shall be evaluated in the preparation of any Circulation Plans and Traffic Impact Analysis. The City Engineer may modify any of the requirements of the driveway location and design standards based on trip generation, topography, and/or the anticipated impacts on traffic safety and movement on the street. Notwithstanding any other provisions of these standards, an access, which demonstrates a potential threat or danger to the public and/or which could affect the safe and efficient flow of traffic, may be denied by the City Engineer, based on commonly accepted and applied traffic engineering principles.

(2) Driveway Design Criteria
The Circulation Plan shall provide for compliance with the minimum standards noted below for access from one or more lots in traditional and conventional areas to a public street:

(3) Number of Driveways Permitted
Access to streets shall be provided to lots either by means of shared access easements, private-drive easements, including frontage or rear access drives, or direct access.

(a) From Arterial Streets

i. Shared-access or private-drive easements shall be used to serve multiple lots. However, when these are unavailable or deemed unnecessary by the City Engineer, then single lots fronting less than six-hundred (600) feet along an arterial street shall have no more than one driveway onto the arterial street.

ii. Lots fronting between six-hundred (600) feet and twelve-hundred (1,200) feet along an arterial street may have a second driveway, provided that the City Engineer may approve additional driveways based on trip generation or topography.

iii. Lots fronting in excess of twelve-hundred (1,200) feet along an arterial street may have additional driveways, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impact to traffic safety and movement on the street will be minimal.

iv. Driveways serving the same lot shall be a minimum of two-hundred and fifty (250) feet apart, measured from the nearest point of the radius return of the two driveways.

v. Access to a corner lot fronting on two arterial streets shall be required to have access from the street with the lower average daily traffic volume. Access to a corner lot fronting on an arterial street, and bordered by a collector or local street, shall be required to have access only from the collector or local street. A lot may be permitted to have an additional driveway from the abutting arterial street, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impacts on traffic safety and movement on the street will be minimal. Approval may be conditioned upon other geometric improvements which will mitigate traffic impacts.

See **Figure 3.3.25(3)a** for design criteria.

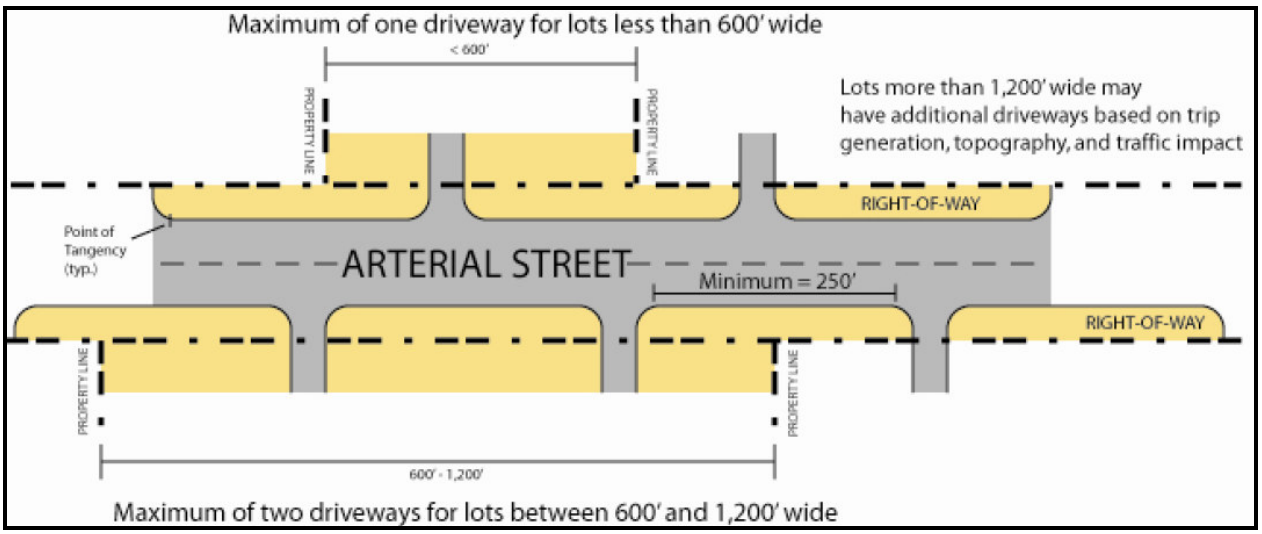


Figure 3.3.25(3)a – Arterial Street Driveway Spacing Criteria

(b) From Collector Streets

i. Single lots fronting less than three-hundred (300) feet along a collector street shall have no more than one driveway onto the collector street.

ii. For nonresidential uses, lots fronting more than three-hundred (300) feet along a collector street may have more than one driveway, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impacts on traffic safety and movement on the street will be minimal.

iii. Driveways shall be a minimum of one-hundred fifty (150) feet apart, measured from the nearest point of the radius return of the two driveways.

iv. Access to a corner lot fronting on two collector streets shall be required to have access from the street with the lower average daily traffic volume. Access to a corner lot fronting on a collector street, and bordered by a local street, shall be required to have access only from the local street. A lot may be permitted to have an additional driveway from the abutting collector street, provided that the City Engineer may approve the driveway based on trip generation or topography, and it is determined that the impact on traffic safety and movement on the street will be minimal.

v. In general, no access shall be permitted to residential lots from collector streets. However, where no alternative access is available, residential lots with one-hundred and twenty-five (125) feet of frontage or less shall be permitted to have one driveway. Residential lots fronting in excess of one-hundred and twenty-five (125) feet along a collector street may have more than one driveway, provided that the City Engineer may approve an additional driveway only if it will have a minimal impact on traffic safety and movement on the street. Driveways shall be a minimum of fifty (50) feet apart, measured from the nearest point of the radius return of the two driveways.

See **Figure 3.3.25(3)b** for design criteria.

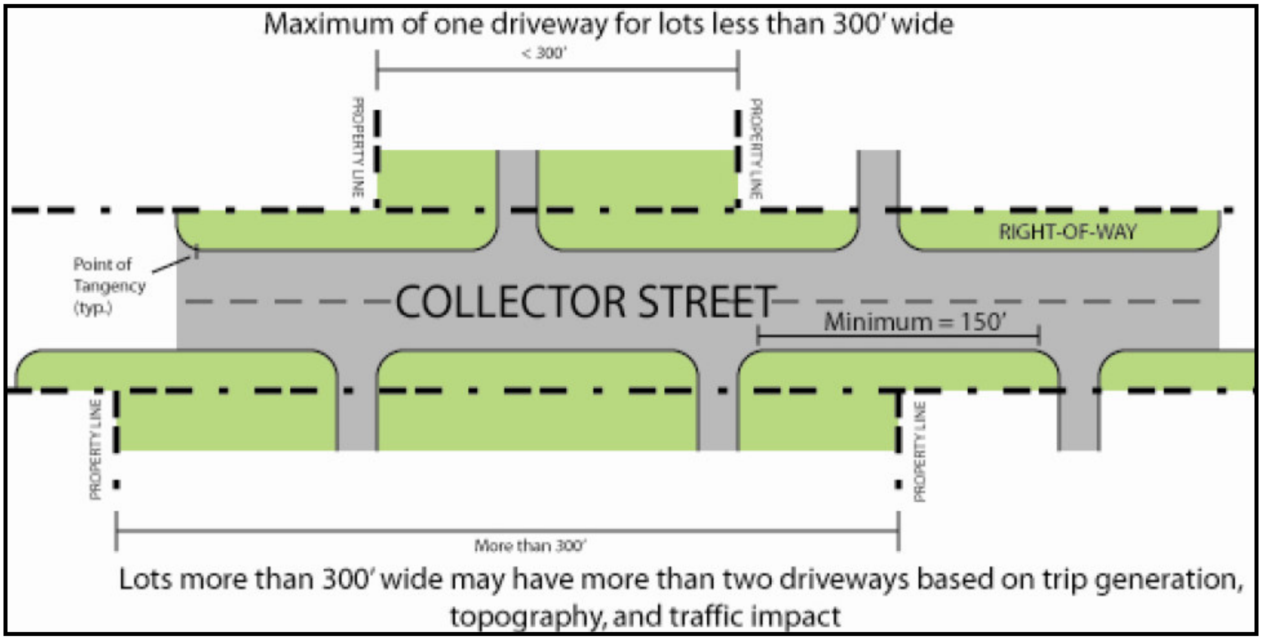


Figure 3.3.25(3)b – Collector Street Driveway Spacing Criteria

(c) From Local Streets

i. There shall be no more than one driveway for lots fronting less than one hundred and twenty-five (125) feet along a local street.

ii. Lots fronting in excess of one-hundred and twenty-five (125) feet along a local street may have more than one driveway, provided that, if approved by the City Engineer for nonresidential uses or the Codes Department for residential uses, the additional driveway will be justified based on trip generation or topography, and it is determined that the impact on traffic safety and movement will be minimal. Driveways shall be a minimum of fifty (50) feet apart, measured from the nearest point of the radius return of the two driveways.

See **Figure 3.3.25(3)c** for design criteria.

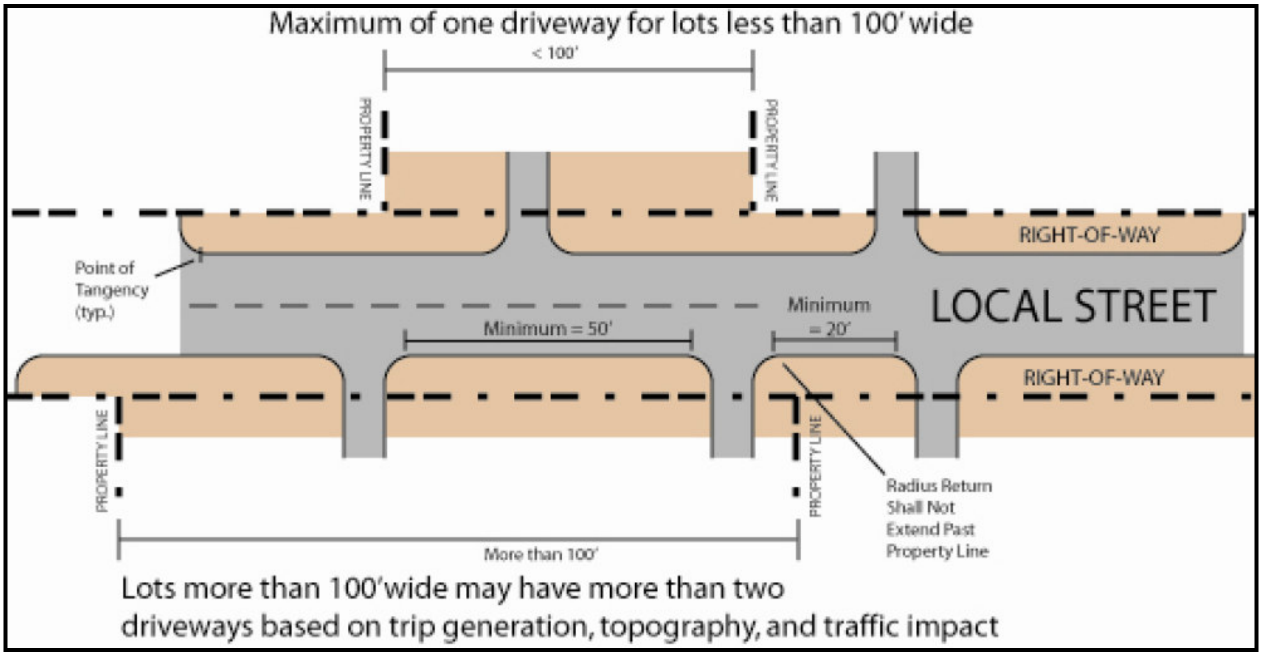


Figure 3.3.25(3)c – Local Street Driveway Spacing Criteria

(4) Minimum Distance from Intersections

(a) No driveway to an arterial street shall be established within two-hundred and fifty (250) feet of an intersecting street. See **Figure 3.3.25(4)a** for design criteria.

(b) On collector streets, no driveway shall be established within two-hundred and thirty (230) feet of an intersecting street. See **Figure 3.3.25(4)b** for design criteria.

(c) On local streets, no driveway shall be established within one-hundred and twenty-five (125) feet of an intersecting street. See **Figure 3.3.25(4)c** for design criteria.

(d) All distance measurements shall be made from the nearest point of tangency of the curve of the intersecting street right-of-way to the nearest point of radius return of the driveway.

(e) For residential uses, a corner lot abutting two local streets may have a driveway with less than the above required distance from the intersecting street, if, in the opinion of the City Engineer, the driveway will not adversely affect traffic safety and movement on the streets.

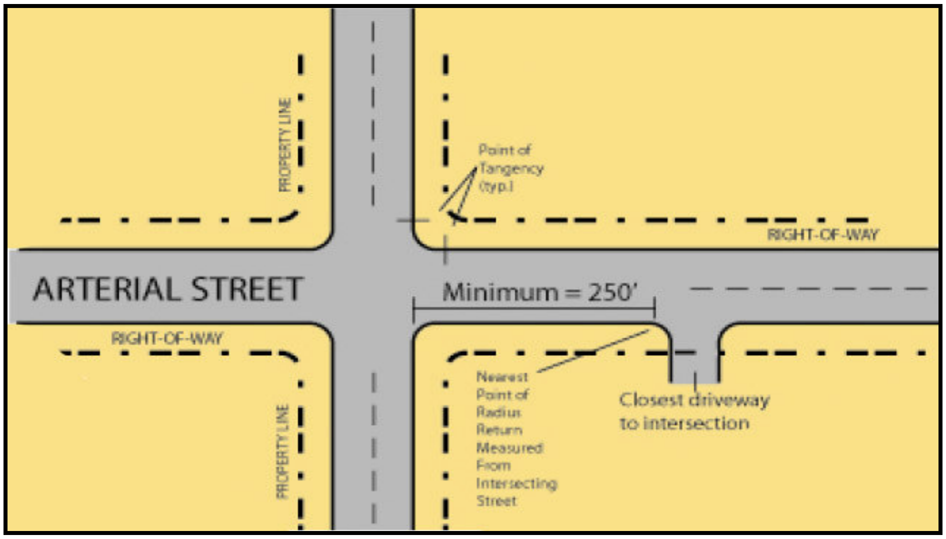


Figure 3.3.25(4)a – Arterial Street Driveway Intersection Clearance

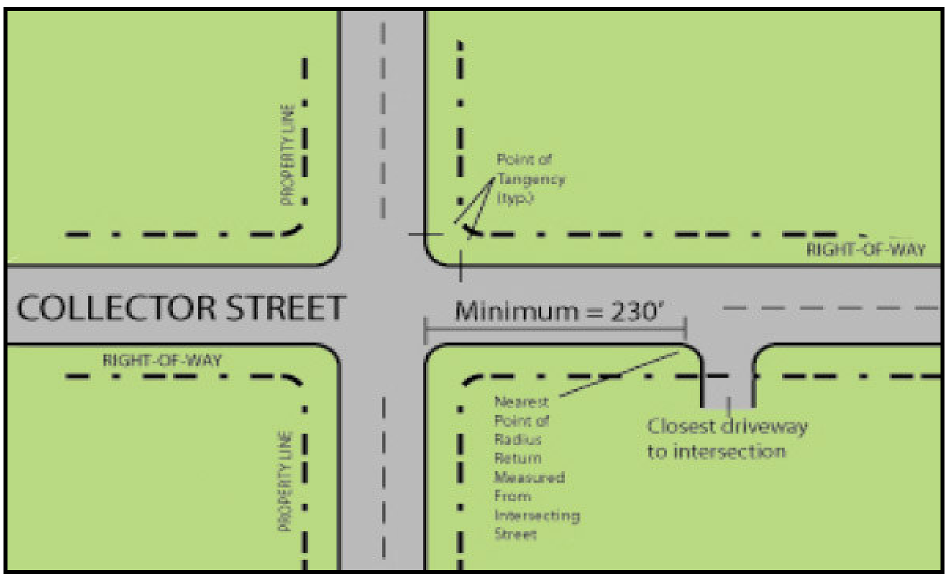


Figure 3.3.25(4)b – Collector Street Driveway Intersection Clearance

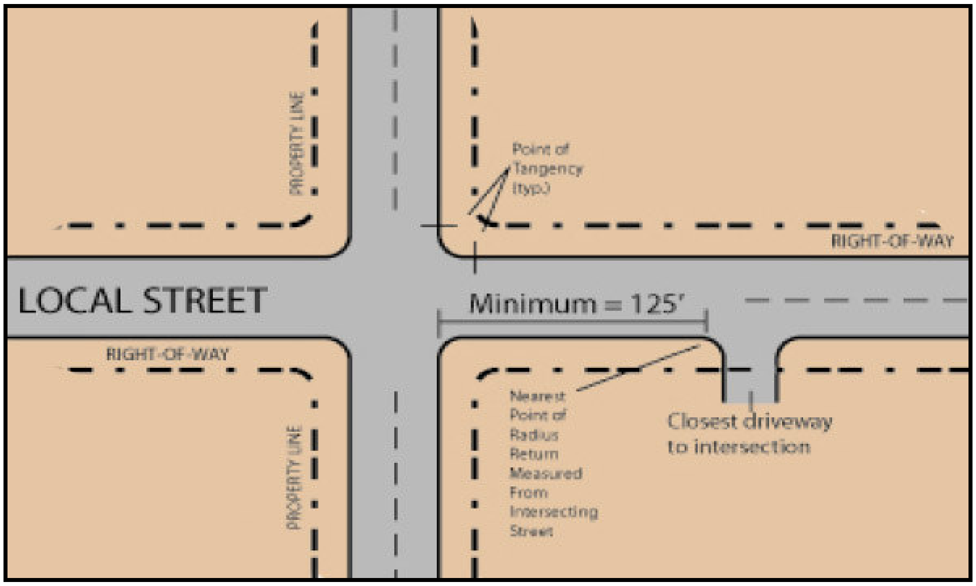


Figure 3.3.25(4)c – Local Street Driveway Intersection Clearance

(5) Minimum Distance Between Driveways on Separate Lots

(a) For nonresidential uses, no two driveways serving separate lots on an arterial street shall be less than two-hundred and fifty (250) feet apart. See **Figure 3.3.25(4)a** for design criteria.

(b) On collector streets, no two (2) driveways serving separate lots shall be less than one-hundred and fifty (150) feet apart. See **Figure 3.3.25(4)b** for design criteria.

(c) On local streets, no two (2) driveways serving separate lots shall be less than twenty (20) feet apart. The distance between driveways shall be measured from the nearest point of the radius return of the two (2) driveways. See **Figure 3.3.25(4)c** for design criteria.

(d) The minimum separation distance may be reduced, provided that, if approved by the City Engineer for nonresidential uses, or the Codes Department for residential uses, the following conditions exist, based on commonly accepted and applied traffic engineering principles: the use of shared-access or private street easements is not feasible or possible; exceptional topographic constraints or unusual site conditions exist at the driveway location (such as in-place utility or drainage features) which would make strict application of the standard exceptionally and/or practically difficult or unduly harsh; application of this section would conflict with other sections of this ordinance; and where the reduction would not constitute a threat or danger to the safe and efficient flow of traffic.

(6) Minimum Distance from Property Line

No driveway, other than a shared-access driveway, shall extend beyond a straight line projection of any side or rear lot line; provided, however, that the provisions may be waived subject to approval by the City Engineer for nonresidential uses or the Codes Department for residential uses.

(7) Deceleration Lanes

(a) Approval of a nonresidential use driveway to an arterial or a collector street may be conditioned upon construction of a deceleration lane. The lanes shall be required in conjunction with each driveway to arterial or collector streets where a proposed land use will increase traffic volumes on the existing street to a total in excess of one-thousand (1,000) vehicle trips per day or one-hundred (100) peak-hour vehicle trips per day. The deceleration lane, a minimum of twelve (12) feet wide, measured from the face of the curb for curb sections without a monolithic gutter, the edge of the gutter for a monolithic curb and gutter section, or the edge of the shoulder line for a non-curbed section to the center of the lane line, shall be constructed to City standards with the length measured from the centerline of the driveway according to the following criteria:

(b) The minimum dimensions of the deceleration lane may be reduced, provided that, it is determined by the City Engineer that, the following conditions exist, based on commonly accepted and applied traffic engineering principles: exceptional topographic constraints or unusual site conditions at the driveway location (such as in-place utility or drainage features) which would make strict application of the standard exceptionally and/or practically difficult or unduly harsh; and the reduction would not constitute a threat or danger to the safe and efficient flow of traffic.

See **Figure 3.3.25(7)** and **Table 3.3.25(7a)** for deceleration lane design criteria.

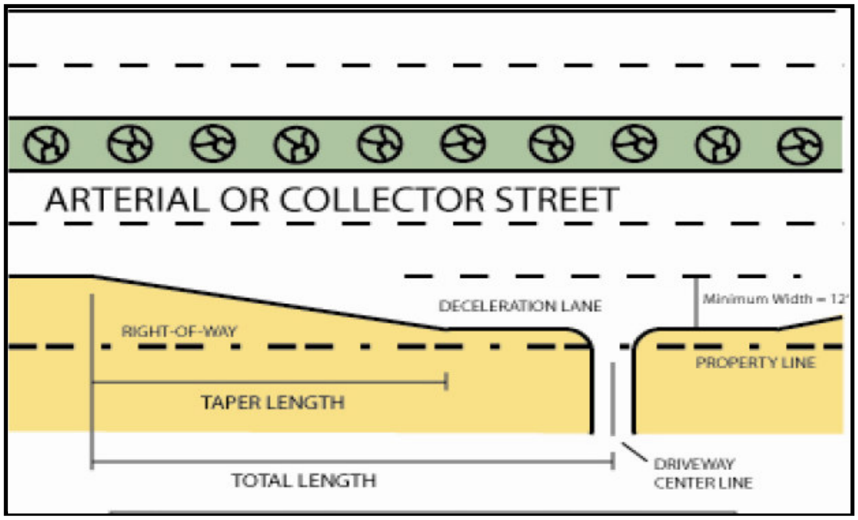


Figure 3.3.25(7) – Deceleration Lane Criteria on Arterial and Collector Streets

Table 3.3.25(7a) Minimum Deceleration Lane Criteria		
Posted Speed Limit	Length of Taper (feet)	Total Length (feet)
35 MPH or less	75	200
40 to 45 MPH	110	250
50 to 55 MPH	150	300

(8) Acceleration Lanes
In instances of unusual topography or traffic safety considerations, the City Engineer may require the construction of an acceleration lane for nonresidential uses. The length of taper and total length shall be determined based on the AASHTO *Green Book* and other commonly accepted and applied traffic engineering principles.

(9) Left-Turn Storage Lane

(a) Approval of a nonresidential use driveway to an arterial street or to a collector street which does not have an exclusive left-turn storage lane may be conditioned upon the construction of a left turn storage lane with appropriate median and/or pavement markings.

(b) The requirement and design of each storage lane, including the paved approach, bay, and departure tapers, shall be determined from the recommendations of the traffic study and approved by the City Engineer based on commonly accepted and applied traffic engineering principles. See **Figure 3.3.25(9)** for design criteria.

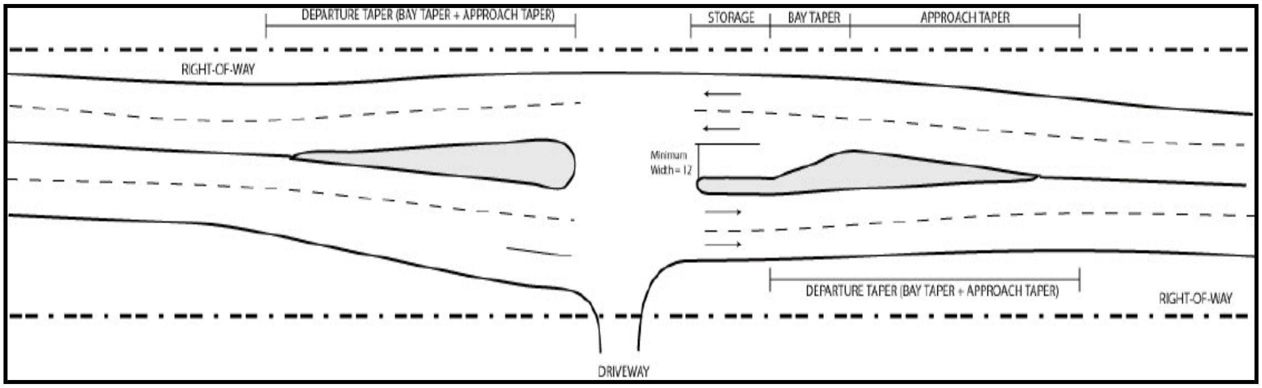


Figure 3.3.25(9) – Left Turn Storage Lane Criteria on Arterial and Collector Streets

(10) Shared-Access Easements

(a) In the re-subdivision of property, the City Engineer may require private driveway easements or other conditions that require multiple lots or parcels to have shared vehicle access locations to arterial or collector streets such as through the use of rear-access or frontage drives where, in accordance with commonly accepted and applied traffic engineering principles, these may be necessary in order to provide for the safe and efficient flow of traffic. Rear-access or frontage drives should be used only when they can be designed properly to provide safe and efficient access for properties.

(b) Where shared-access easements are required, the subdivision plat shall state that the transfer of lots shall be subject to the provision of such easements, which shall provide for a guaranteed, unrestricted, right of access to all other owners providing such easements and that the owners of lots subject to shared-access easements shall be required to execute an agreement specifying responsibility for construction and perpetual maintenance of the easements in accordance with the approved access plan. The agreement shall specify that the parties thereto shall hold the City harmless from liabilities resulting from unsafe conditions on shared-access easements.

Copies of the agreements from the current owners of lots through which shared-access easements are to run shall be filed with the City Engineer. Construction on shared-access easements shall not be commenced until all agreements are filed. Copies of all subsequent amendments to the agreements shall also be filed with the City Engineer.

(c) In the event that the owners fail to maintain shared-access easements in a safe and stable driving condition, the Codes Director, after appropriate notice, may have the unsafe or unstable conditions corrected and bill the owners for all reasonable costs. Should the owners fail to pay the City the amount of such charge within thirty (30) days from receipt of a certified invoice, then the costs shall be certified to the City Attorney, who shall process a lien on the properties upon which the expenditure was made.

See **Figure 3.3.25(10)** for design criteria.

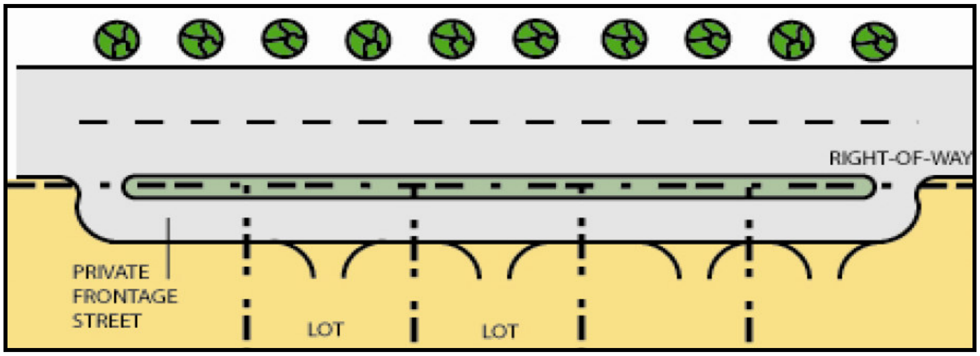


Figure 3.3.25(10) – Shared Access Easement Design Criteria for Arterial and Collector Streets

(11) Driveway Approach Length and Restrictions
Driveways for nonresidential uses must extend a minimum of thirty (30) feet into the property from the lot line abutting the street before the edge of the driveway may be intersected by a parking lot space, aisle, or drive. The minimum length of the driveway restriction may be extended, provided that it is determined by the City Engineer that anticipated traffic volumes and commonly accepted and applied traffic engineering principles justify the need for longer, controlled storage lanes. See **Figure 3.3.25(11)** for design criteria**.**

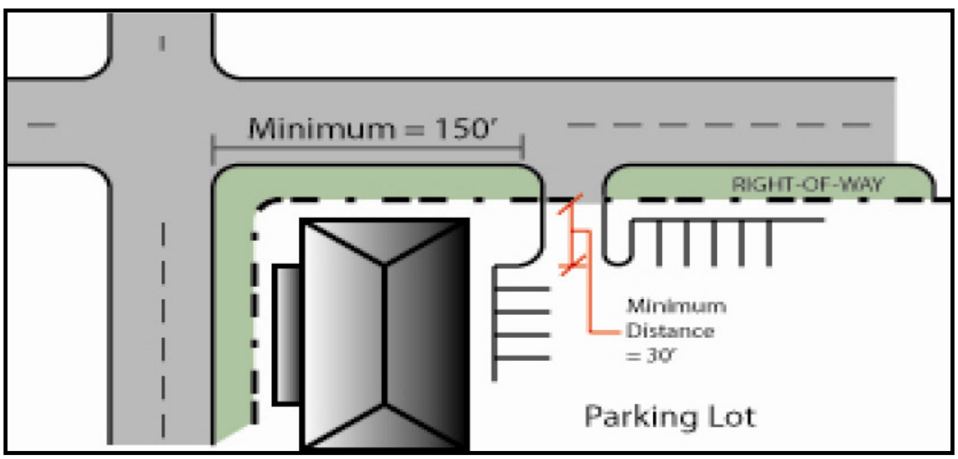


Figure 3.3.25(11) – Driveway Approach Design Criteria

(12) Driveway Width Requirements

(a) The width of driveways, measured at the nearest points of the radius returns, shall meet the requirements in the table below.

(b) Driveways to nonresidential uses may exceed the maximum width, provided that it is determined by the City Engineer that the need to provide safer turning movements and/or the number of trips generated for truck traffic to or from the property will justify the need for additional driveway lanes.

Table 3.3.25(12b) Driveway Width Requirements		
Use	Drive Width (feet)	
	Minimum	Maximum
Residential (to individual dwelling units)	10	20
Nonresidential:		
One-way Traffic	15	20
Two-way Traffic [1]	25	36

[1] Multilane driveways may be wider subject to the approval of the City Engineer.

(13) Median Driveways
Median driveways, in which ingress and egress lanes are separated by a minimum four (4) foot wide raised concrete curb median, may exceed the maximum two-way width, provided that the individual ingress or egress lane will not exceed the limits of one-way access width, and the median will not exceed fourteen (14) feet in width. These dimensions and lanes may be increased for higher-volume driveways if justified by a Traffic Impact Study. Additionally, monuments, walks, vegetation, or signing must not be located in the median in such a way as to interfere with driver vision and safety when entering or exiting the driveway.

(14) Radius of Driveway Curve

(a) The radius of curve connecting the edge of the acceleration or deceleration lane or through-traffic lane and edge of driveway shall meet the requirements of **Table 3.3.25(14a).**

(b) The radius of the driveway curve to nonresidential uses may exceed the maximum radius length, provided that it is determined by the City Engineer that the need to provide safer turning movements and/or the number of trips generated to or from the property for truck traffic will justify the need for additional radius length.

Table 3.3.25(14a) Radius of Driveway Curve		
Use	Radius of Curve (feet) [1]	
	Minimum	Maximum
Residential	5	15
Nonresidential:		
- Arterial Street	25	40
- Collector Street	25	30
- Local Street	10	25

NOTES: [1] A driveway flare may be used instead of a curve for residential uses.

(15) Pavement Markings and Signing
Driveways with more than one ingress or egress lane shall have the pavement surfaced marked with center lines, lane lines, channelization lines, stop lines, and symbol arrows plus traffic control signing in accordance with the requirements of the *Manual on Uniform Traffic Control Devices*, latest revision. The pavement markings and signing shall be continually maintained by the property owner in good condition and visible to drivers at all times.

(16) Materials
All driveway areas within the public right-of-way used for vehicular traffic shall be paved with Portland cement concrete (PCC) from the edge of street pavement to the edge of right-of-way or to the back of the sidewalk, whichever is farthest from the curb. PCC may only be required to extend to the back of sidewalk if approved by the City Engineer. In the event a driveway serving a residential use is crossed by a concrete sidewalk, the portion of the driveway from the sidewalk to the flare of the driveway shall utilize the same material and finish as the sidewalk.

(17) Additional Right-of-Way
The applicant shall provide or dedicate additional right-of-way and/or easement if it is determined by the City Engineer that the right-of-way and/or easement is necessary for street improvements, such as acceleration/deceleration lanes, as established on the approved access plan.

(18) Offset from Opposite Streets
Intersections of streets with Major Arterial streets shall only align with streets intersecting on the opposite side of the Arterial street where a traffic signal or Roundabout will be permitted unless a raised median exists within the Arterial street that restricts the access at the intersections to right-in and right-out turns only. All other intersections must be offset by a minimum of one-hundred and twenty-five (125) feet or greater as required by the City Engineer.

(19) Avoiding Conflicts in Center Left Turn Lane
When establishing the placement of offset accesses (either driveways or intersections), ensure that traffic making left-hand turns into the accesses does not conflict or compete for the simultaneous use of a center left turn lane.

(20) Potential for Future Signalization
For any driveway access to a Major Arterial, an Access Management Plan and a signal progression plan may be required by the City Engineer. Generally, private direct access is discouraged onto a Major Arterial street to allow the Arterial to better meet it's primary function. Public street access to a Major Arterial, where left turns are to be permitted, must meet the signal spacing criteria and the Access Management Plan. Access points that do not meet these requirements shall normally be limited to right turns only, unless they meet the requirements above.

(21) Public Street Intersection Spacing
Local streets should not typically intersect Major Arterials, but where they do they should be spaced at a minimum of six-hundred and sixty (660) feet. Full movement access to Major Arterials should be limited to one-half mile intervals wherever possible, plus or minus approximately two-hundred (200) feet, in order to achieve good speed, capacity, and optimal signal progression. However, to provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

Non-signalized full access to Minor Arterials should be limited to one-quarter mile intervals, plus or minus approximately one-hundred (100) feet, in order to achieve good speed, capacity, and optimal signal progression. Signalized intersections shall still be spaced at one-half mile spacing. However, to provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

(22) Right Turns Only
Left turns may be prohibited, allowing right turns only. If left turns are restricted, raised medians will be required to prevent the left turn movements. Access points to arterials will normally be limited to right turns only (through signing and a raised median), unless:

> **(a)** The access has the potential for signalization, in accordance with the general spacing requirements in this section,
>
> **(b)** Left turns would not create unreasonable congestion or safety problems and not appreciably lower the level of service, and
>
> **(c)** Alternatives to the left turns would not cause unacceptable traffic operation and safety problems to the general street system.

(23) Entrance-Only and Exit-Only Approaches
Driveway approaches, where the driveway is to serve as either an entrance-only or exit-only drive, shall be appropriately signed by, and at the expense of, the property owner to guide motorists in proper driveway operation. The property owner shall provide whatever means are necessary to ensure that motorists will use the driveway in the intended manner.

(24) Adequate Intersection Sight Distance
To the extent possible, all openings for driveways shall be located at a point of adequate sight distance along the street. Accesses to commercial establishments shall have sufficient space reasonably clear of any obstructions to provide drivers entering the property sufficient sight distance for proper and safe movements.

(25) Profile
The profile of a driveway approach and the grading of the adjacent area shall be such that when a vehicle is located on the driveway outside the traveled portion of the street the driver can see a sufficient distance in both directions to enter the street without creating a hazardous traffic situation. The driveway profile grade within twenty (20) feet of the flow line shall not exceed eight (8) percent unless a variance is approved by the City Engineer. Driveways within the sidewalk and parkway area of the right-of-way shall slope toward the street. See **Figures 3.3.25(25)1** and **3.3.25(25)2** for allowable grades and grade breaks for driveway approaches.

(26) Adjustments for Existing Structures
Any adjustments made to utility poles, street light standards, fire hydrants, catch basins or inlets, traffic signs and signals, or other public improvements or installations required for the curb openings or driveways shall be accomplished without cost to the City.

(27) Access to Streets with No Curb and Gutter
Private drive access to Local, Collector, or Arterial streets that have no curb and/or gutter improvements shall be constructed to meet the following requirements:

(a) Surface Requirements: The driveway shall extend from right-of-way line to edge of existing driving surface and shall be constructed with a minimum of three and one-half (3.5) inches of asphalt or concrete.

(b) Right-of-Way: New driveway accesses from private property to existing pavement shall be paved within the right-of-way. On Local rural streets HBP or concrete pavement shall be installed from the right-of-way line to the edge of the traveled street. The width of the driveway within the right-of-way shall be twelve (12) to twenty-two (22) feet.

(c) Culvert: A culvert shall be installed at the established roadside ditch flow-line elevation beneath the private drive access. The culvert diameter shall be specified by the approved storm drainage report or in absence of the report by the City. A culvert shall be installed in the flow-line of the borrow ditch of a size necessary for the design storm flow (fifteen (15) inch minimum diameter). The pipe shall have flared end sections. The minimum cover over the culvert should be one (1) foot. Additional cover may be required for heavy vehicles.

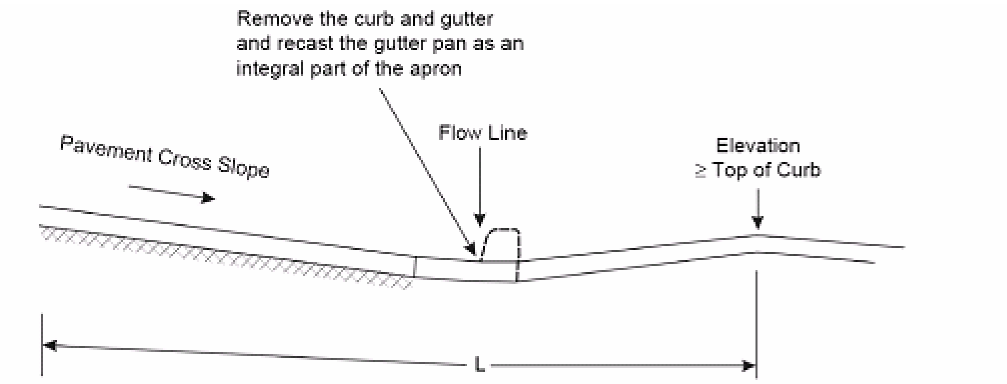
(d) Sketch Plan: A drawing of the proposed driveway installation showing all dimensions shall be submitted with the right-of-way or Access permit application.

(28) Entrance Angle
In general, the entrance angle for all driveway approaches and intersections shall be as near ninety degrees (90°) to the centerline of the street as possible. The minimum angle that will be permitted is ninety degrees (90°) plus or minus ten degrees (10°) for a minimum of twenty-five (25) feet measured perpendicular to the street and measuring from the curb or edge of pavement toward the private property served.

(29) Access Approaches
Access approaches shall not be approved for parking or loading areas that require backing maneuvers within the right-of-way except on Local Residential streets. All off-street parking areas on Collector and Arterial streets must include on-site maneuvering areas and aisles to permit user vehicles to enter and exit the site in forward drive.

(30) Minimum Off-Street Parking Set Back Distance
Parking maneuvers within a parking lot shall not restrict entering vehicles from safely and efficiently entering the driveway from the public street. The minimum parking setback distance for non-residential driveways is 30 feet from the right-of-way line as described in **Section 3.3.25(11).** The City Engineer may increase this distance based on a Traffic Impact Study.

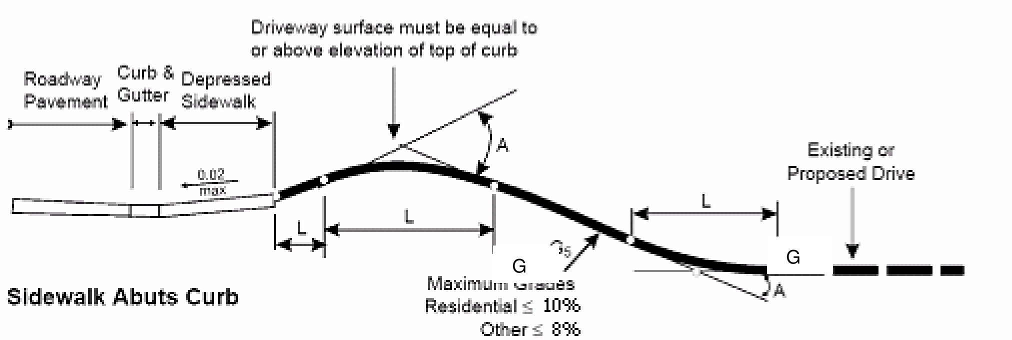
FIGURE 3.3.25(25)1 DRIVEWAY PROFILE DESIGN CRITERIA

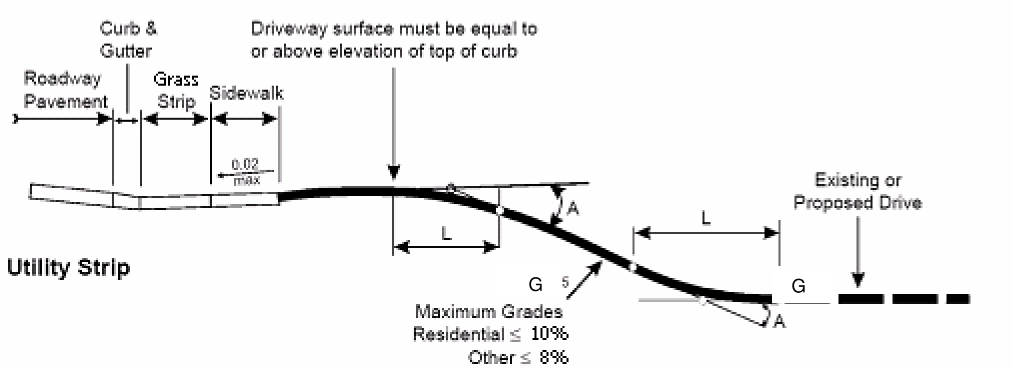


Suggested Apron Length

Street Class	L ft
Major Arterial	≥ 20
Commercial Collector	15
Residential Collector	10-15
Local Residential	10

Dimensions that will result in an appropriate driveway profile (*3*).



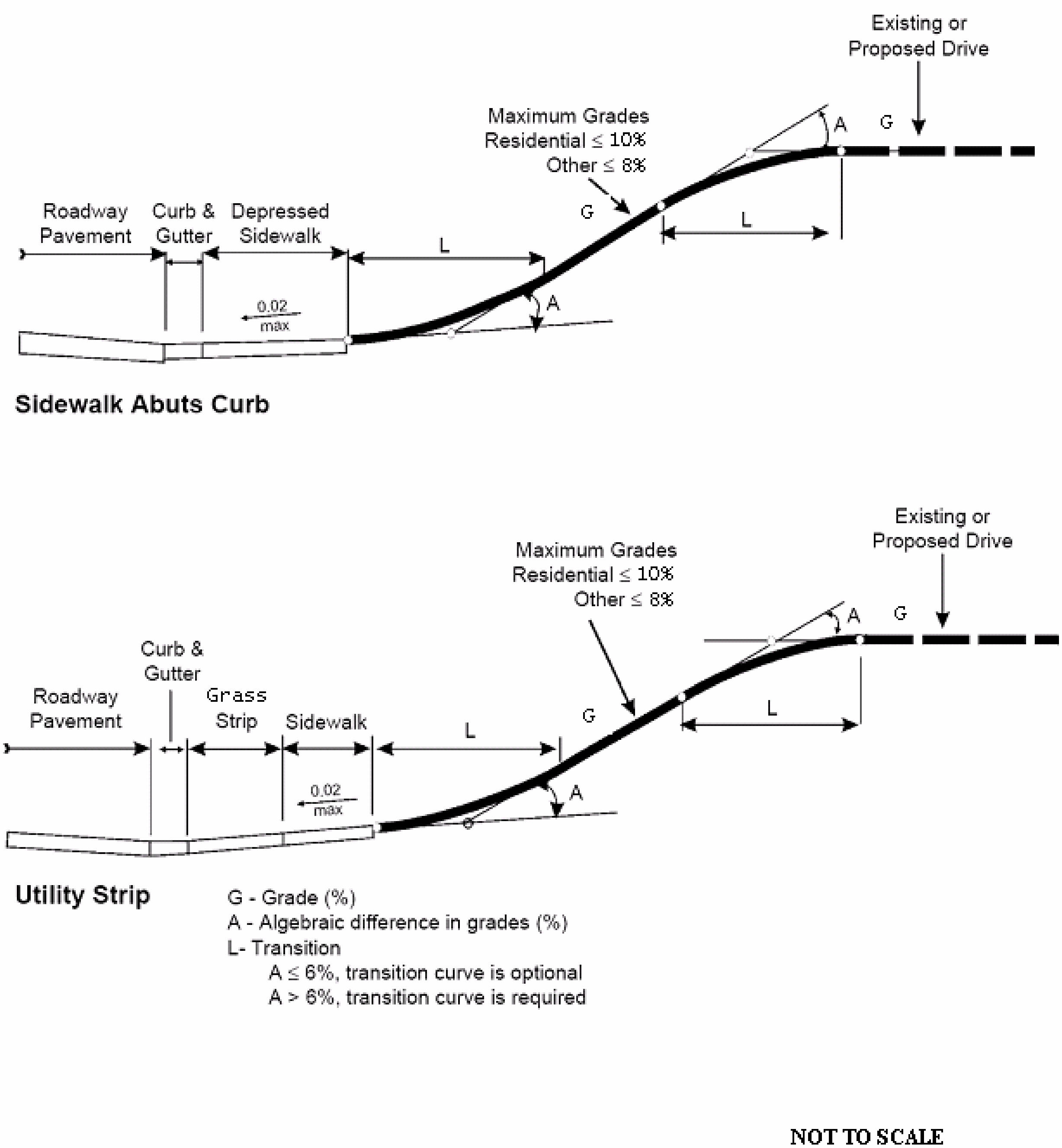


G - Grade (%)
A - Algebraic difference in grades (%)
L - Transition
A ≤ 6%, transition curve is optional
A > 6%, transition curve is required

NOT TO SCALE

Driveway Profile Design Criteria
Figure 3.3.25(25)1

FIGURE 3.3.25(25)2 DRIVEWAY DESIGN CRITERIA



Driveway Profile Design Criteria
Figure 3.3.25(25)2

(31) Drainage

(a) Drainage at Curb Cuts: Where curb cuts are allowed, concentrated storm water runoff from property adjoining the right-of-way shall not be discharged across the sidewalk. These flows must be directed elsewhere or directed to a sidewalk chase where storm water may pass under a sidewalk section.

(b) Sheet Flow Drainage: Sheet flow drainage is allowed where it does not interfere with the pedestrian use of the sidewalk.

(32) Change in Use
If the use of an existing access to right-of-way changes, or there is a change in the use of the property, the change in access use must be approved through the development review process, access management plan, or the City work in right-of-way or access permit. Change in access or property use may include, but is not limited to, change in the amount or type of traffic (twenty (20) percent or twenty-five (25) vehicles per hour, whichever is less), structural modifications, remodeling, change in type of business, expansion in existing business, change in zoning, change in property division creating new parcels, etc.

(33) Un-permitted Access
Any access, driveway, or curb-cut which is constructed within public right-of-way without a right-of-way or access permit issued by the City (or State if a State highway) shall be subject to removal. Failure to remove the un-permitted access may result in the removal of said access by the City. The cost for removal shall be charged to the property owner from which the access originates.

(34) Abandoned Access
If a parcel of land with direct access has been in a state of non-use for more than one year, re-commencement of access use shall be considered a change in use. If the use of the access exceeds the design limitations of the access or does not conform with the present code, a new approval may be required through the development plan review process, access management plan, or the City's work in right-of-way permit.

(35) Removal
Any curb opening or driveway that has been abandoned shall be removed and restored by the property owner except where such abandonment has been made at the request of, or for the convenience of, the City.

(36) Access Permit Required/Appeals

(a) No curbs or rights-of-way shall be cut, paved, or otherwise altered for the purposes of obtaining access until a permit approving the access cut has been secured from the City and/or any other governmental agency owning or controlling street right-of-way.

(b) Whenever the City disapproves the location and design of a residential access, or when it is claimed that an equally good or more desirable access plan can be employed, or when it is claimed that the true intent and meaning of these standards have been misconstrued or wrongly interpreted, then the property owner, or his duly authorized agent, may appeal the decision to the City Engineer.

3.4 Pedestrian Facilities

All streets designed in Conventional areas of the City shall accommodate pedestrian travel as called for in this chapter of these standards and further defined in the City's *Bicycle and Pedestrian Plan* (latest edition). See the **Zoning Ordinance** for special requirements in Traditional areas. For the purposes of street design, it is assumed that pedestrian walking speeds are three and one-half (3.5) feet per second.

3.4.1 ADA Requirements

All pedestrian facilities provided within a City street right-of-way or easement shall be designed to accommodate movement by the disabled as required by the "North Carolina Accessibilty Code" and the *Americans with Disabilities Act* (ADA for disabled access in the public right-of-way.

3.4.2 Typical Sections

(1) Sidewalk Location
The minimum cross sections for sidewalks are presented in the typical sections at the end of this chapter. These cross-sections are consistent with the City's *Bicycle and Pedestrian Plan* and should be used to construct sidewalks along both sides of a street. As shown, the cross sections are dependent upon the classification of the street on which they are located. For additional information regarding street classifications and street cross-sections, see **Section 3.2**.

(2) Residential Area Sidewalks
On a local or collector street (in a residential area) that has curb and gutter; the sidewalk shall be a minimum of five (5) feet wide and constructed of concrete. The front edge of the sidewalk shall be set back five (5) feet behind the back of curb. This area should be landscaped with grass and can include trees and other landscaping materials provided that adequate sight distance is maintained. Street signs, street lights, and other street appurtenances should be placed in the grass strip area, typically in the center. Fire hydrants may be located in the grass strip or behind the sidewalk. A one (1) foot wide graded area, with a maximum 6:1 slope, should be provided at the back edge of the sidewalk. Vertical objects should be placed at least one (1) foot from any sidewalk edge.

(3) Commercial Area Sidewalks
On a collector street (in a commercial area) that has curb and gutter; the sidewalk should be eight (8) feet wide and constructed of concrete. The front edge of the sidewalk should be set back a minimum of five (5) feet from the back of curb. This area should be landscaped with grass and can include trees and other landscaping materials provided that adequate sight distance is maintained. Street signs, street lights, and other street appurtenances should be placed in the grass strip area, typically in the center. Fire hydrants may be placed in the grass strip or behind the sidewalk. A one (1) foot wide graded area, with a maximum 6:1 slope, should be provided at the back edge of the sidewalk. Vertical objects should be placed at least one (1) foot from the sidewalk edge.

(4) Urban Arterial Street Sidewalks
On an arterial street (in an urban area) that has curb and gutter; the sidewalk shall be a minimum of eight (8) feet wide and should be constructed of concrete. The front edge of the sidewalk should be set back at least six (6) feet behind the back of curb in conventional areas (see Chapter 5 the Zoning Ordinance for requirements in traditional areas). This area can be landscaped with grass or can be constructed of concrete. Trees and other landscaping materials can also be used in the grass strip area provided that adequate sight distance is maintained. Street signs, street lights, and other street appurtenances should be placed in the grass strip area, typically in the center. Fire hydrants may be placed in the grass strip or behind the sidewalk. Buildings should be set back at least four (4) feet from the back edge of the sidewalk, creating a frontage strip for the adjacent properties. This frontage strip should be constructed of concrete. Sidewalk cafes, sidewalk planters, benches, and other pedestrian features can be located in the frontage strip. Vertical objects should be placed at least one (1) foot from the sidewalk edge. See typical sections at the end of this chapter.

(5) Suburban Arterial Street Sidewalks
On an arterial street (in a suburban area) that has curb and gutter; the sidewalk shall be a minimum of five (5) feet wide and constructed of concrete. The front edge of the sidewalk should be set back at least six (6) feet from the back of curb. This area should be landscaped with grass and can include trees and other landscaping materials provided that adequate sight distance is maintained. Street signs, street lights, and other street appurtenances should be placed in the grass strip area, typically in the center of this buffer. Fire hydrants may be placed in the grass strip or behind the sidewalk. A one (1) foot wide graded area, with a maximum 6:1 slope, should be provided at the back edge of the sidewalk. Vertical objects should be placed at least one (1) foot from the sidewalk edge. See typical sections at the end of this chapter.

(6) Sidewalks on Streets with Ditches
On a street that has ditches instead of curb and gutter; the sidewalk should be five (5) feet wide and constructed of concrete. It should also be located behind the ditch when possible. Vertical objects should be placed at least one (1) foot from the sidewalk edge. A one (1) foot wide graded area that has a maximum slope of 6:1 should be provided on each side of the sidewalk. The grass strip buffer, which contains the ditch and is located between the innermost graded area and the edge of the street, should be at least five (5) feet wide and should be landscaped with grass. Drainage requirements may dictate an increased ditch section. In severe circumstances, the City Engineer may allow a five (5) foot wide paved shoulder could be constructed adjacent to the edge of the street. This shoulder could be used by pedestrians or bicyclists. A one (1) foot wide graded area that has a maximum slope of 6:1 could be provided at the back edge of the shoulder. The ditch could be located behind this graded area.

3.4.3 Managing Access for Pedestrian Safety

Unlimited access creates many points where conflicts may occur between pedestrians and vehicles entering or leaving the street. By restricting the number and size of driveways along a street, many of these potential conflicts can be avoided. Multiple driveways that have multiple lanes and continuous access driveways should be avoided. When possible, multiple driveways should be combined. If these driveways serve adjacent properties, cross-access drives between the properties should be provided in order to eliminate the need for multiple driveways. These recommendations are consistent with the City's current access ordinance. Continuous access driveways should be re-designed to create a limited number of entry/exit points. This design should include grass strips between the street and the parking lot to prevent access at unwanted locations.

3.4.4 Intersections

All intersections should be designed with the assumption that pedestrians will be present. Signalized intersections should have crosswalks that are clearly marked. They shall also have ramps, landings, pedestrian push buttons, and other pedestrian features that are accessible to everyone. The signing and pavement markings at intersections should clearly indicate how all street users should operate.

3.4.5 Sidewalk Ramps

A sidewalk ramp should be constructed for each crosswalk at each street corner, as illustrated in the Standard Drawings**.** In addition to providing the shortest, direct route between sidewalks, this practice makes it easier for pedestrians crossing the street to see right-turning vehicles. If only a single, diagonal sidewalk ramp is provided at a street corner, then right-turning vehicles approach pedestrians crossing the intersecting street from behind. If two perpendicular sidewalk ramps are provided, then right-turning vehicles will approach the pedestrians from the side.

3.4.6 Corners

An obstruction-free area should be provided at street corners between the curbs and a continuation of the adjacent property lines**.** At a minimum, this distance should be twenty feet. Only pedestrian push button posts and other pedestrian features should be located in this area.

3.4.7 Crosswalks

(1) Crosswalk Locations
Crosswalks should be provided on each leg of all intersections where significant pedestrian activity is encouraged or exists.. They should be clearly marked with a "ladder" pattern, as shown in the Traffic Control chapter**,** so that they are highly-visible to all street users. Crosswalks that are marked with reflective white thermoplastic tape are more visible than those that are marked with brick or cobblestone, especially at night and during rain. Crosswalks that are marked with brick or cobblestone can be made more visible by outlining them with reflective white thermoplastic tape or white concrete outline. However brick and cobblestone are not recommended for crosswalks because these materials can create bumpy paths that are difficult for people with limited mobility to navigate.

Standard Crosswalk

(2) Mid-block Crosswalks
Mid-block crosswalks are generally discouraged in the City due to safety concerns associated with pedestrians crossing streets at unprotected locations. Before a mid-block crosswalk is approved for installation by the City Engineer, a pedestrian crossing study shall be conducted to address the need for and expected use of the crossing. Should a crossing be recommended by the study and approved by the City, a traffic and safety analysis shall be completed to determine the optimum design elements of the crossing.

3.4.8 Signals & Timings

The MUTCD identifies the situations in which pedestrian signal shall be used and the situations in which pedestrian signals should not be used. Because one should assume that pedestrians will be present at all intersections in the City to some level, all signalized intersections should be designed to accommodate pedestrians. Other locations that have high pedestrian volumes with marked crosswalks may also warrant the installation of a dedicated pedestrian actuated traffic signal, subject to review and approval by the City Engineer.

Chapter 9 of this document, the MUTCD and the *ADA Accessibility Guidelines for Buildings and Facilities* should be consulted regarding pedestrian signal timings. Pedestrian signals should utilize universal symbolized messages, as outlined in the MUTCD, rather than letters. The MUTCD uses the term "Walking Person" to describe the white illuminated figure that symbolizes the WALK interval. The "Upraised Hand" is used to describe the orange illuminated figure that symbolizes the DON'T WALK interval. According to the MUTCD, a minimum of seven seconds should be allocated to the WALK signal. The amount of time dedicated to the DON'T WALK signal should be based on the pedestrian walking speed and the crossing distance. According to ADA *Accessibility Guidelines for Buildings and Facilities*, a pedestrian walking speed of three and one-half (3.5) feet per second should be assumed at all intersections. This document also states that the crossing distance should equal the length of the crosswalk plus one sidewalk ramp.

3.4.9 Push Buttons

Pedestrian pushbuttons should be used at pedestrian crossings that have low, intermittent pedestrian volumes. The design and placement of pedestrian pushbuttons should meet the following criteria:

- The pushbutton should be located a maximum of five (five) feet away from the extension of the crosswalk lines and within ten (10) feet of the curb/shoulder/pavement.
- If two (2) pushbuttons of the Accessible Pedestrian Signal (APS) type are located on the same street corner, they should be separated by at least ten (10) feet.
- The pushbutton shall be accessible to a person in a wheelchair on the level landing at the top of the sidewalk ramp.
- The pushbutton box should face the pedestrian standing at the curb on alignment with the crosswalk.
- An arrow should clearly indicate which crosswalk will be affected by the pushbutton.
- Standard pedestrian signal instructions should be mounted near the pushbutton.

Typical pedestrian Push Button

- A pushbutton should be present at each leg of a signalized intersection that does not have a fixed-time pedestrian phase.
- The pushbutton should include an illuminated confirmation light to acknowledge that a call has been detected.
- At intersections with known handicapped crossing activity, Accessible Pedestrian Signal (APS) equipment should be used.
- At intersection approaches with heavy directional turns, the pedestrian crossing may be omitted on the side of the approach with the heavy turning conflicts, so long as a pedestrian crossing is used on the other side of the approach.

See **Chapter 9** for more information on pedestrian signals.

3.4.10 Detectable Warning Surfaces

The *Draft Guidelines on Accessible Public Rights* calls for detectable warnings for pedestrian street crossings, including curb ramps and blended transitions, certain median and refuge islands, and rail lines. These surfaces feature a distinctive pattern of raised domes to provide a tactile cue detectable by cane or underfoot at the boundary between pedestrian and vehicular routes. The City's standard material for installing detectable warnings shall be tactile brick pavers.

3.4.11 Transit Stops

Transit stops should typically be located at the far side of an intersection**.** This design encourages pedestrians to cross behind the bus, improving their visibility to oncoming vehicles. A bus stop located on the near side of an intersection blocks the site lines between pedestrians and motorists. The preferred location for a transit stop waiting area is in the buffer strip between the sidewalk and the street. This waiting area should be at least eight (8) feet wide by twenty-five (25) feet long and should be constructed of concrete. If severe physical constraints require the transit stop to be located outside of the buffer strip, then the transit stop should be located in the frontage strip. This design should include a concrete waiting area that is at least six (6) feet wide by twelve (12) feet long.

3.4.12 Grade-Separated Pedestrian Crossings

Grade-separated pedestrian crossings may be warranted across freeway, expressway or arterial streets where the volume of projected vehicular and pedestrian traffic justifies the expense of such a facility. Before any grade-separated crossing is approved, a feasibility study shall be completed which analyzes the need for the crossing as well as its impacts on adjacent properties and costs. A critical element of grade-separated crossings is the need to ensure that pedestrians shall actually utilize the crossing and cannot cross the major street at-grade. Any design of grade-separated crossings shall consider this need and incorporate fences, landscaping or other physical elements to achieve this result. Where the grade separation directs the pedestrians under the street, the subway path shall be substantially illuminated.

3.5 Bicycle Facilities

All streets designed in the City shall accommodate bicycle travel as called for in this chapter of these standards and further defined in the City's *Bicycle and Pedestrian Plan* (latest edition). Specific streets as outlined in the Plan shall receive the design treatments so designated.

Typical bike lane with signing and markings

3.5.1 Types of Facilities

A bicycle lane is a travel lane that is between four (4) and six (6) feet wide and that is designated for exclusive use or preferential use by bicyclists. Bicycle lanes are separated from conventional travel lanes with a lane stripe and are identified by pavement markings and signing. These facilities should be one-way facilities, located on the right side of the street, that carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. Another type of bicycle lane is a shoulder bikeway. A shoulder bikeway is a paved shoulder that is at least four (4) feet wide and that is separated from motor vehicle traffic by a lane stripe. It is also designated by signing. Unlike a bicycle lane, a shoulder bikeway is not designated exclusively for bicyclists. It may serve as a location to temporarily park a damaged vehicle, or it may serve other functions. Typically, shoulder bikeways are applied to rural streets that do not have curb and gutter.

3.5.2 Bicycle Shared Streets

A shared street is a street in which motorists and bicyclists share the same travel lanes. There are three types of shared streets. These are:

- Wide outside lane (WOL)
- Signed shared roadway (SSR)
- Local street

(1) A WOL is a conventional travel lane, located on the right side of the street, that is typically fourteen (14) to fifteen (15) feet wide and that is shared by motorists and bicyclists. The extra width that is provided by a WOL allows motorists to comfortably pass bicyclists without changing lanes and without getting too close to the bicyclists. WOLs are identified by signing and can include pavement markings.

(2) A SSR is a street that is shared by motorists and bicyclists and is identified by signing. Unlike WOLs, SSRs do not provide additional street width for bicyclists. However, they should provide features that make them suitable for bicyclists. These features include traffic control devices that are sensitive to bicyclists, bicycle-safe storm grates, and smooth pavement surfaces. They should also be routinely swept in order to prevent debris from accumulating on the street. Typically, SSRs are reserved for streets that have a high demand for bicycle traffic but cannot accommodate a bicycle lane or WOL due to physical constraints. SSRs should be considered as temporary bicycle facilities and should be replaced by bicycle lanes or WOLs as soon as this is feasible.

(3) Local streets are typically low-speed, low-volume streets. Therefore, they do not usually require special treatment in order to accommodate bicyclists. However, signing may be used to identify a through-bicycle route that follows a local street.

3.5.3 Multi-use Paths/Greenways

A multi-use path/greenway is a designated facility that is used for bicycling, walking, running, skating, and other forms of non-motorized travel. It is physically separated from motorized vehicular traffic by a barrier or open space, and can be located within a street right-of-way or an independent right-of-way.

Paths/greenways are typically twelve (12) feet wide. They are not part of the street network, but may travel parallel to certain street segments. Also, these facilities may follow the course of natural boundaries, such as rivers and streams, or man-made boundaries, such as railroad lines and utility easements. See typical sections at the end of this chapter.

3.5.4 Bicycle Typical Sections

The recommended cross-sections for bicycle lanes, shared streets, and multi-use paths are presented in the typical sections at the end of this chapter. These cross-sections are generally consistent with the recommendations of the City's *Bicycle and Pedestrian Plan*. In addition to the recommendations contained in this plan, AASHTO's *Guide for the Development of Bicycle Facilities* and the *Manual on Uniform Traffic Control Devices* (MUTCD) should be consulted in order to determine appropriate pavement markings, signing, etc. for new bicycle facilities.

(1) As shown in the cross-sections, on-street bicycle lanes shall be between four (4) feet and six (6) feet wide. On streets that have curb and gutter but do not have on-street parking, this width should be accommodated between the outermost lane and the gutter pan.

(2) On streets that have on-street parking, a five (5) to six (6) foot wide bicycle lane should be located between the parking lane and the outermost travel lane. Bicycle lanes located on a paved street shoulder should be at least four (4) feet wide, with a preferred width of six (6) feet.

(3) A WOL should be the outermost vehicular travel lane. WOLs should be at least fourteen (14) feet wide. This width does not include the curb and gutter. See the City's *Bicycle and Pedestrian Plan* for additional guidance on WOL.

(4) A "shared-signed" bicycle facility is one which is accommodated in a standard, outermost travel lane. See the City's *Bicycle and Pedestrian Plan* for additional guidance on SSR facilities.

(5) Multi-use paths should be at least twelve (12) feet wide. For multi-use paths that are directly adjacent to streets or are heavily used, the City Engineer may determine that the width should be wider than twelve (12) feet. A minimum two (2) foot wide shoulder and clear zone should be provided on each side of a multi-use path.

3.5.5 Bicycle Pavement Markings

(1) Bicycle facilities should be designated with pavement markings. In addition to the recommendations contained in this plan, AASHTO's *Guide for the Development of Bicycle Facilities* and the *Manual on Uniform Traffic Control Devices* (MUTCD) should be consulted in order to determine appropriate pavement markings for new bicycle facilities. A bike lane should be separated from motor vehicle travel lanes by a solid white line that is six (6) inches wide. The width of this line can be increased to eight (8) inches for added distinction. If on-street parking is present, a four (4) inch wide solid white line should be used to separate the bike lane from the parking lane.

(2) Bike lanes should be identified with standard pavement symbols. The City's *Bicycle and Pedestrian Plan* shows the symbols that are typically used to designate bicycle lanes, as well as their proper placement. A shoulder bike lane should be separated from motor vehicle travel lanes by a solid white line that is six (6) inches wide. Because shoulder bike lanes can be used for other functions, such as a place to park a damaged vehicle, pavement markings should not be used to identify shoulder bike lanes.

(3) WOLs and SSRs should be identified by the shared lane pavement marking. If on-street parking is present, a four (4) inch wide solid white line should be used to separate the bike lane from the parking lane. Multi-use paths/greenways do not require pavement markings. However, it is recommended that a solid centerline paint stripe be provided on these facilities in order to separate the different directions of travel.

See the City's *Bicycle and Pedestrian Plan* for additional guidance on bicycle pavement markings.

3.5.6 Bicycle Signing

Bicycle facilities should be designated with signing. In addition to the recommendations contained in City's *Bicycle and Pedestrian Plan*, AASHTO's *Guide for the Development of Bicycle Facilities* and the *Manual on Uniform Traffic Control Devices* (MUTCD) should be consulted in order to determine appropriate signing for new bicycle facilities. Signs should be used in moderation in order to avoid distracting street users. When signs are used, they should be highly visible and easily understood by all street users. Signs that are directed at bicyclists are smaller versions of standard street signs. This is because bicyclists typically travel at slower speeds than motorists and are typically closer to the signs than motorists are. Standard street signs that are directed at motorists also apply to bicyclists.

The MUTCD provides guidance on bikeway signing and placement of bikeway signing. Bike lane signs (R3-16 and R3-17) are to be used only when bike lanes are marked with the bicycle lane symbol pavement markings. The “Bicycle Lane Ahead” sign (R3-16) and the “Bicycle Lane Ends” sign (R3-16a) are to be used in advance of the beginning of a marked bike lane and when a marked bike lane ends. The “Share the Road” sign (W11-1/W16-1) should be used in conjunction with the “Bicycle Lane Ends” sign. Installation of the “Right Lane Only” sign (R3-17) is recommended at periodic intervals along the bike lane. Bicycle route signs (D11-1, M1-8, M1-9, and all supplemental plaques) should always include accompanying directional or bikeway identification information. Where bike lanes are present, such signs are only needed at major intersections and where the route changes streets. Where bike lane segments are discontinuous, bike route signs should include information that directs bicyclists from one bike lane segment to another. Bike route signs should also direct bicyclists to popular destinations.

In areas where motorists chronically park in bike lanes, the “No Parking” signs (R7-9 and R7-9a) should be used. However, bike lane pavement markings typically solve this problem without the need for signs. When motorists must weave across bicycle traffic to enter a right turn lane, a “Begin Right Turn Lane/Yield to Bikes” sign (R4-4) should be used. This sign should be placed at the beginning of the taper or at the point of the beginning of the weave.

On shared streets, bicycle route signs (D11-1,M1-8, M1-0, and all supplemental directional plaques) should always include accompanying directional or bikeway identification information. Route signs should be provided at major intersections, where routes change streets, and at intervals not greater than one thousand (1,000) feet.

See the City's *Bicycle and Pedestrian Plan* for additional guidance on bicycle signing.

3.5.7 Intersections

Intersections should be designed so that a bicyclist's path of travel is direct, logical to both bicyclists and motorists, and is as similar to the path of motor vehicle travel as possible. Also, bike lanes should extend to the stop line/ crosswalk and should not extend through the pedestrian crossing.

(1) T-Intersections
Bike lanes at T-intersections should be constructed according to the design illustrated in the City's *Bicycle and Pedestrian Plan*. As shown, left and right turn lanes for bicycles should be provided unless severe physical constraints prevent the construction of two bicycle turn lanes. If physical constrains do exist, then the bicycle turn lanes can be omitted as long as the vehicular left turn lane is fourteen (14) feet wide. With either design, the bike lane across from the intersection should be striped through the intersection. However, this bike lane should not be striped through the crosswalks.

(2) Intersections without Exclusive Right Turn Lanes
When a bike lane is present at an intersection that does not have an exclusive right turn lane, the solid bike lane stripe should be replaced with a dashed line at least fifty (50) feet prior to the stop line/crosswalk.

(3) Intersections with Exclusive Right Turn Lanes
At intersections with exclusive right turn lanes, the paths of motorists and cyclists should cross in advance of the intersection in order to reduce the number of conflicts that occur at the intersection. The pavement

markings should direct bicyclists to the left of the exclusive right turn lane. The bike lane stripes should be dashed across the area where motorists should cross into the right turn lane. The solid bike lane markings should resume when the right turn lane achieves full width and should continue to the stop line/crosswalk. Under severe physical constraints, the bike lane can be terminated if the outermost through lane is fourteen (14) feet wide.

(4) Intersections with Dual Right Turn Lanes
At an intersection with a right turn lane and a shared through/right turn lane, the bike lane should terminate at the location where the taper for the right turn lane begins. A dashed line should be striped between the edge of pavement at the terminus of the bike lane to the lane stripe between the dual right turn lanes. The shared through/right turn lane should be fourteen (14) feet wide. Also, signing alerting motorists and bicyclists of the approaching lane configuration is recommended.

(5) Complex Intersections
Intersections of multiple streets and intersections that have offset lanes or skewed streets can create confusion for motorists and bicyclists. When possible, these intersections should be realigned so that the intersecting streets are perpendicular to each other, with only two streets intersecting at a given point. If a complex intersection cannot be avoided, then bike lanes at the intersection should be defined with a dashed line strip through the intersection. However, the bike lanes should not be striped through the crosswalks.

3.5.8 Signal Timing and Detection

Bicyclists are required to follow the rules of the road, including those related to traffic signals. Therefore, signal timing and detection should accommodate the needs of bicyclists. Traffic signal clearance intervals are recommended to be timed to provide bicyclists with sufficient time to react, accelerate, and proceed through an intersection on the clearance interval. Normally, a bicyclist can travel through an intersection under the same signal phasing arrangement as motor vehicles. However, special consideration of bicyclists' needs may be necessary at multi-lane crossings and at acute angle intersections, which take longer to cross. The clearance interval should take into consideration a bicyclist's speed of 6-8 MPH, and a perception/reaction/braking time of one (1.0) second. Traffic detectors for traffic-actuated signals are recommended to be set to detect bicycles.

There are various types of detector loops that can be used for bicycle lanes. Quadruple and diagonal quadruple loop detectors generally provide for bicycle detection, unlike standard loops, which are difficult to adjust to detect bicycles. Detectors should be located in the bicyclist's expected path of travel. When bicycle lanes are not present, pavement markings should be used to indicate where bicyclists should position themselves in order to activate the signal detector.

See **Chapter 9** for more information on traffic signal timing and detection.

3.5.9 Other Related Design Considerations

(1) General
All streets should be designed and maintained to eliminate safety hazards for bicyclists, regardless of the presence of a bicycle facility. For example, storm grates should be level with the pavement and have bars that run perpendicular to the flow of traffic. Pavement surfaces should be smooth and not have cracks or joints that run parallel to the flow of traffic. Streets should be swept regularly to remove debris. Also, street bridges and construction zones should be designed to accommodate bicycle traffic.

(2) Design Standards
In general, the City's *Bicycle and Pedestrian Plan* and AASHTO'S *Guide for the Development of Bicycle Facilities* should be used as the standard for making design decisions. Most local bicycle design standards in the United States are based on the AASHTO guide. However, because the AASHTO guide is general in scope, many local bicycle design standards include refinements and additional guidance on specific design issues. For example, AASHTO provides basic coverage of intersection design, but because these locations can be major barriers to bicycle travel and are where most accidents occur, additional standards have been developed in the City Plan to augment the AASHTO guidelines.

3.6 Traffic Calming

3.6.1 General

This section presents acceptable methods of neighborhood traffic calming that are determined by the City to be acceptable for use on existing local streets. This chapter also provides for specific design criteria for a number of traffic calming methods.

(1) Intended Use

The necessity or desire for traffic safety and calming stems from the perception that local streets, particularly in residential areas, do not always function as intended. These streets should be low traffic volume streets used for direct access to residences on the street. They are also intended as a multi-modal system that is shared by vehicular, bicycle, and pedestrian traffic equally, in a manner that minimally impacts residents in these areas.

(2) For New Street Design

The devices presented in this section are generally not intended for use on new streets. New street design is addressed earlier in this section. New local streets are to be designed to minimize cut through traffic, high volumes, and high speed operation and to maximize the efficiency of the street to provide vehicular access and bicycle and pedestrian traffic. Circulation plans prepared for new streets serving residential, nonresidential, and mixed-use development shall comply with the following standards:

> **(a)** Minimal street widths, short block lengths, on-street parking, controlled intersections, roundabouts, and other traffic calming measures shall be used on all local and minor collector streets to the maximum extent practicable.
>
> **(b)** In cases where residential development has been organized around a grid street network, measures to interrupt or terminate long vistas exceeding twelve-hundred (1,200) feet in length shall be employed to the maximum extent practicable. Such measures shall include, but shall not be limited to:
>
> i. Curvilinear street segments;
> ii. Street jogs or off-sets designed to require vehicles to slow their travel speed;
> iii. Street chicanes or neckdowns;
> iv. Terminated vistas;
> v. Mid-block traffic circles; and
> vi. Stop signs at street intersections, where warranted.

3.6.2 Traffic Calming Design Criteria

For existing local streets that are approved for Traffic Calming, the policies and guidelines of the adopted Neighborhood Traffic Calming Program (NTCP) document shall apply, as described below.

(1) Application

This policy applies to local, residential streets. Collector and arterial streets and streets that are located in commercial zoning districts will not be considered for traffic calming.

(2) Process

Projects that are being considered for the NTCP must follow the procedure that is outlined below. A flowchart summarizing this procedure is provided in **Figure 3.6.2(2)**.

PROCEDURAL FLOW CHART FOR THE DRAFT NEIGHBORHOOD TRAFFIC CALMING PROGRAM (NTCP) FRANKLIN, TENNESSEE

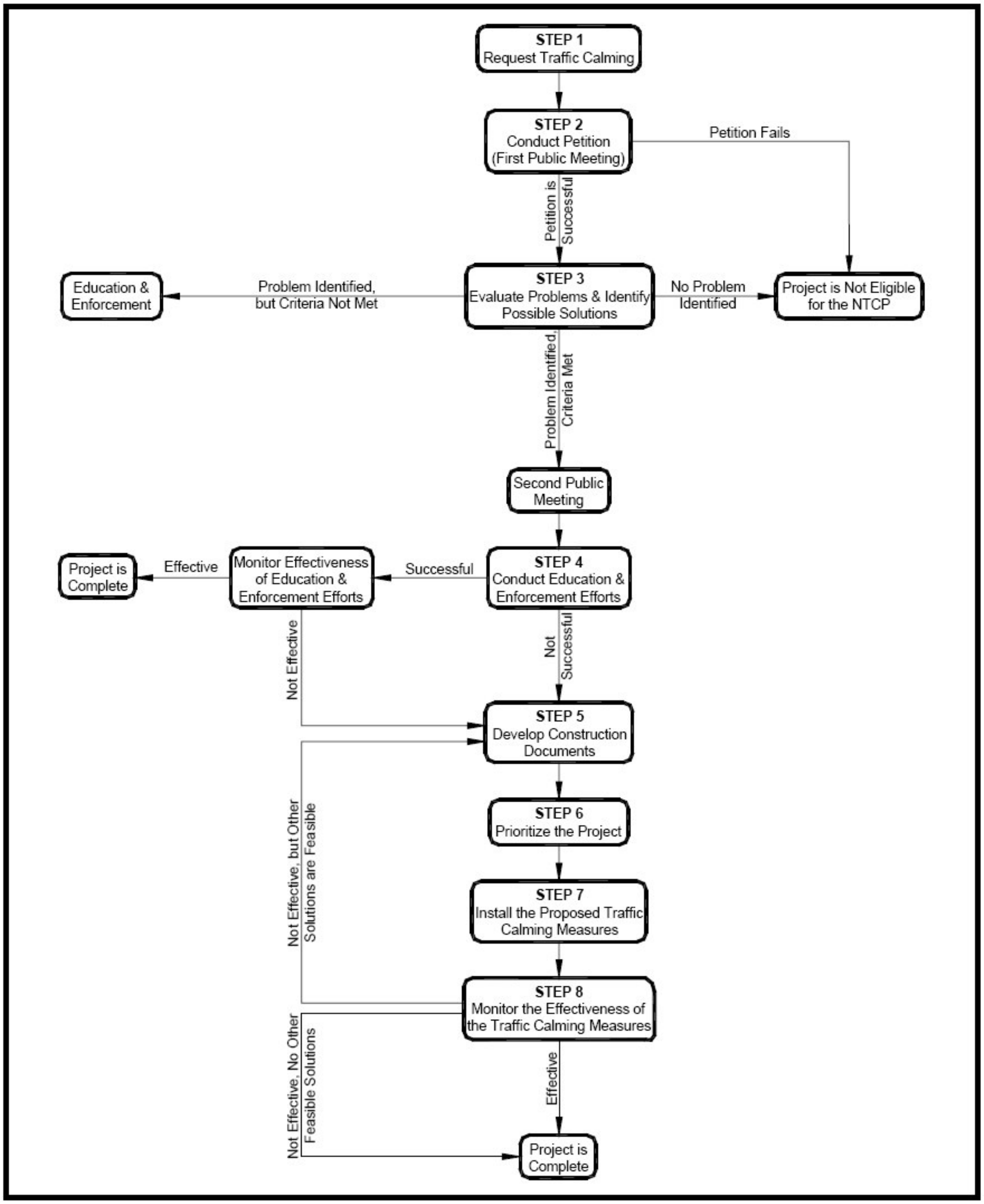


Figure 3.6.2(2)

Step 1: Request Traffic Calming

A homeowner's association or homeowner's group must submit a written request for traffic calming on a specific street segment or segments to the City Engineer. The request must identify the perceived traffic problem and must include contact information for a representative (the requester) of the association/group. Individual citizens are not eligible to initiate projects for the NTCP.

Step 2: Conduct Petition

Upon receipt of the written request, the City Engineer will define the petition area. The petition area will typically include the following:

- Properties along the street that is being considered for traffic calming measures
- Properties along streets where access is substantially dependent upon the street that is proposed to be calmed
- Properties along any street that is expected to receive significant increases, as determined by the City Engineer, in traffic volumes or types as a result of the traffic calming installation

The City Engineer will prepare a petition packet that includes the petition form, a copy of the NTCP policy, a map of the study area, the names and addresses of the property owners within the petition area, and an explanation of the NTCP procedures. The petition packet will be given to the requester, who will be responsible for conducting the petition. Prior to conducting the petition, the traffic calming request and petition must be presented at a neighborhood meeting that is publicized by the City in a manner that is consistent with the City's standard procedures. The City Engineer will attend the meeting to present the traffic calming request, identify the study area, and to explain the NTCP procedures. After the meeting, the requester must obtain supporting signatures, or "yes" votes, that represent fifty-one (51) percent of the households within the petition area. Missing signatures will be counted as "no" votes. The requester will have ninety (90) days after the date of the neighborhood meeting to submit the petition results to the City Engineer. If the petition is successful, then the proposed project will proceed to Step 3. If the petition fails, or if the petition is not returned by the petition deadline, then the project is terminated, and the neighborhood will be ineligible to submit another request for traffic calming for a period of one (1) year.

Step 3: Evaluate Problems and Identify Possible Solutions

The City Engineer will evaluate the project to determine the need for traffic calming measures. This evaluation will typically include a site visit and the collection of data, such as traffic volumes and traffic speeds. In order for a project to be considered for traffic calming measures, the following criteria must generally be met:

- The Average Daily Traffic (ADT) volume is greater than or equal to 500 vehicles per day.
- The 85th percentile speed is at least 7 MPH faster than the posted speed limit.
- The posted speed limit is 35 MPH or less.
- The street is a through street.
- The maximum grade on the section of roadway that is being considered for traffic calming measures does not exceed eight percent.
- The combination of horizontal and vertical curves along the roadway is not such that would result in inadequate stopping sight distance for motorists as they encounter the traffic calming devices.
- The street is not a transit route or a primary emergency access route.

If the City Engineer determines that the street segment does not have a traffic volume or a traffic speed problem, then the project will be terminated. The project will be ineligible for the NTCP for a period of two (2) years unless the City Engineer determines that changing conditions have resulted in a traffic volume or speeding problem. If the City Engineer determines that a street segment has a traffic volume or a traffic speed problem, but the above criteria are not met, then the City Engineer will work with the

Police Department and the neighborhood association/group to address the problem with education and enforcement efforts. However, the street will not be considered for other traffic calming measures at this time. Also, the project will be ineligible for the NTCP for a period of two years unless the City Engineer determines that changing conditions during this time have resulted in a traffic volume or speeding problem.

If the City Engineer determines that a street segment has a traffic volume or a traffic speed problem, and if the above criteria are met, then the project will be included in the NTCP. The City Engineer will identify feasible and appropriate traffic calming solutions to address the identified traffic problem. Examples of traffic calming techniques are provided in the standard drawings. The City Engineer will then attend a publicized, neighborhood meeting to present the results of the analyses and the identified solutions. Based on comments received at the meeting, the City Engineer will revise the solutions as appropriate. The project will then proceed to Step 4.

Step 4: Conduct Education and Enforcement Efforts
All projects in the NTCP will begin with education and enforcement efforts, which will involve the coordinated efforts of the City Engineer, the Police Department, and the neighborhood association/group. The neighborhood association/group must actively participate in this process in order for the project to continue in the NTCP. Education and enforcement efforts will be applied for a period of not less than three months and not more than six months. If the City Engineer determines that these efforts have not sufficiently addressed the identified problem, then the project will proceed to Step 5.

If the City Engineer determines that the education and enforcement efforts have addressed the identified problem, then the project will be considered complete. The City Engineer will continue to monitor the project for a period of one year. If the identified problem returns during this time, then the requester will be notified, and the project will proceed to Step 5. If the identified problem does not develop during this one year period, then the project will be considered complete. If the identified problem returns after this one-year period, or if a new traffic volume or traffic speeding problem develops after this one-year period, the homeowner's association/group must return to Step 1 in order to be considered for the NTCP again.

Step 5: Develop Construction Documents
Based on the feasible and appropriate solutions identified by The City Engineer during Step 3, the City Engineer will develop a complete set of construction documents for the proposed traffic calming measures.

Step 6: Prioritize the Project
Projects that reach Step 5 will be prioritized by the City Engineer based on a variety of factors, such as traffic speeds, traffic volumes, and implementation costs. The City Engineer will notify the requester of the project's status at this time. This prioritization will be used by the City Engineer to develop construction schedules for the projects.

Step 7: Install the Proposed Traffic Calming Measures
Projects will be implemented according to priority and the availability of funding. Projects that have the highest priority will be implemented first. If sufficient funding is not available for the highest priority project, then the highest priority project that can be implemented with the amount of funding that is available will be implemented first. A lower-priority project can be implemented ahead of schedule if the neighborhood association/group elects to pay 100 percent of the implementation costs and as long as doing so does not affect the construction schedules of higher-priority projects. Implementation of a project will not occur until all associated maintenance/landscape/payment agreements have been finalized. Installation of the traffic calming measures will be performed by City crews or by a contractor that is selected by the City.

Step 8: Monitor the Effectiveness of the Traffic Calming Measures
Approximately three months after the proposed traffic calming devices have been installed, the City Engineer will evaluate the project to determine if the traffic calming

devices have sufficiently addressed the traffic problem identified during Step 3. If the traffic problem has been resolved, then the project will be considered complete. If the traffic problem has not been resolved, then the City Engineer will consider other solutions that were identified during Step 3. If an alternate solution is selected by the City Engineer, then the project will return to Step 5. If the City Engineer determines that there are no feasible alternatives, then the project will be terminated and will not be considered for inclusion in the NTCP again unless changing conditions have resulted in a feasible alternative. If this is the case, it will be the responsibility of the neighborhood association/group to submit another written request for traffic calming to the City Engineer, and the entire NTCP process must be repeated.

(3) Modification or Removal of a Traffic Calming Device

(a) Process

If the City Engineer determines that a traffic calming device should be modified or removed due to public health/safety reasons, then the City Engineer, with assistance from the Street Department, shall modify or remove the device. If the neighborhood association/group wishes to remove or significantly alter a traffic calming device, then the neighborhood must conduct the same petitioning process outlined in Step 2. If the petition supporting the removal/modification is successful, then the neighborhood must pay for the costs that are associated with the removal/modification. A traffic calming device will not be removed until all payment agreements have been finalized. If the removal/modification is initiated by the neighborhood association/group, then the neighborhood will be ineligible to participate in the NTCP for a period of five years.

3.6.3 Traffic Calming Techniques

(1) Approved Techniques

There are a variety of techniques that can be used to calm traffic on local, residential streets. Techniques that are specifically permitted, as well as techniques that are specifically prohibited, in the City are described below. Techniques that are specifically permitted are summarized in the following table, which also identifies the potential benefits and disadvantages of each.

Table 3.6.3(1)
POTENTIAL IMPACTS OF TRAFFIC CALMING TECHNIQUES THAT MAY BE USED IN THE CITY OF FRANKLIN

Measure	Potential Benefits			Potential Disadvantages			Cost
	Speed Reduction	Volume Reduction	Conflict Reduction	Limits Local Access	Increases Emergency Response Time	Extent of Maintenance Required	
Chicane	●	●	●	○	◐	◐	$$ - $$$
Curb Extension	◐	○	○	○	○	◐	$ - $$
Education	◐	○	◐	○	○	○	$
Enforcement	◐	○	◐	○	○	○	$ - $$
Lower Speed Limit	◐	○	○	○	○	○	$
Raised Median	◐	○	◐	◐	○	◐	$ - $$
Road Diet	◐	○	◐	○	○	○	$ - $$$
Speed Table/Hump	●	◐	●	○	◐	◐	$ - $$
Traffic Circle	●	◐	●	○	◐	◐	$$ - $$$

● Substantial Benefits/Disadvantages ◐ Minor Benefits/Disadvantages ○ No Benefits/Disadvantages

$ Low Cost $$ Moderate Cost $$$ High Cost

(a) Chicane: A chicane shifts motorists' path of travel by creating a horizontal diversion in the roadway. A chicane is usually formed by a series of curb extensions that are placed on alternating sides of the roadway. These curb extensions reduce the roadway width and force motorists to steer from one side of the roadway to the other in order to travel through the chicane. See **Standard Drawing 3.6.3(1)a** for a typical drawing of this technique.

(b) Curb Extensions: Curb extensions are formed by extending the curb on one or both sides of the roadway into the vehicular travel lanes to reduce the paved roadway width. The reduction in width creates “slow points” in traffic flow. Curb extensions are also commonly referred to as chokers, neckdowns, traffic throats, and pedestrian bulbs. Curb extensions reduce the width of the roadway at intersections and create shorter crossing distances for pedestrians. The reduction in lane width encourages motorists to slow down when driving through the intersection. See **Standard Drawing 3.6.3(1)b** for a typical drawing of this technique.

(c) Education: Education is a key component of all traffic calming projects in the City. Before implementing physical traffic calming measures, the City Engineer will work with participating neighborhoods to educate their residents regarding safe, on-street, vehicular travel. The City Engineer will assist the neighborhood associations/groups in developing educational programs for the residents. However, it will be the responsibility of the neighborhood associations/groups to implement the educational programs.

(d) Enforcement: Enforcement efforts will be combined with neighborhood education as a first step in all traffic calming projects in the City. The Police Department will work with the City Engineer to help resolve traffic problems, such as speeding. Enforcement efforts may involve the use of speed trailers and may include tickets for violators.

(e) Lower Speed Limits: Establishing lower speed limits may help to reduce speeding and cut-through traffic in residential neighborhoods. Some local, residential roadways have speed limits that are posted at 30 MPH or more. It may be desirable to lower the speed limits on these roadways to the City’s default speed limit, which is 25 MPH for local, residential streets.

(f) Raised Median: A raised median is an elevated island that is constructed on the centerline of a two-way street to reduce the width of the adjacent travel lanes. Raised medians can be paved or landscaped. They create “slow points” in the roadway, can serve as pedestrian refuges for pedestrians crossing the street, and can be used in conjunction with other traffic calming measures. See **Standard Drawing 3.6.3(1)f** for a typical drawing of this technique.

(g) Travel Lane Reduction: Reducing the number of travel lanes, or the width of travel lanes, on a roadway can be an effective technique for calming traffic on that street. This process, called a “road diet”, can help to reduce vehicular speeds, reduce the number of conflict points for right-of-way users, and can help make streets more bicycle and pedestrian-friendly. Road diets can be accomplished by adding parking lanes, adding bike lanes, adding a median, or by reclaiming some of the roadway width, which can create room for sidewalks and street trees.

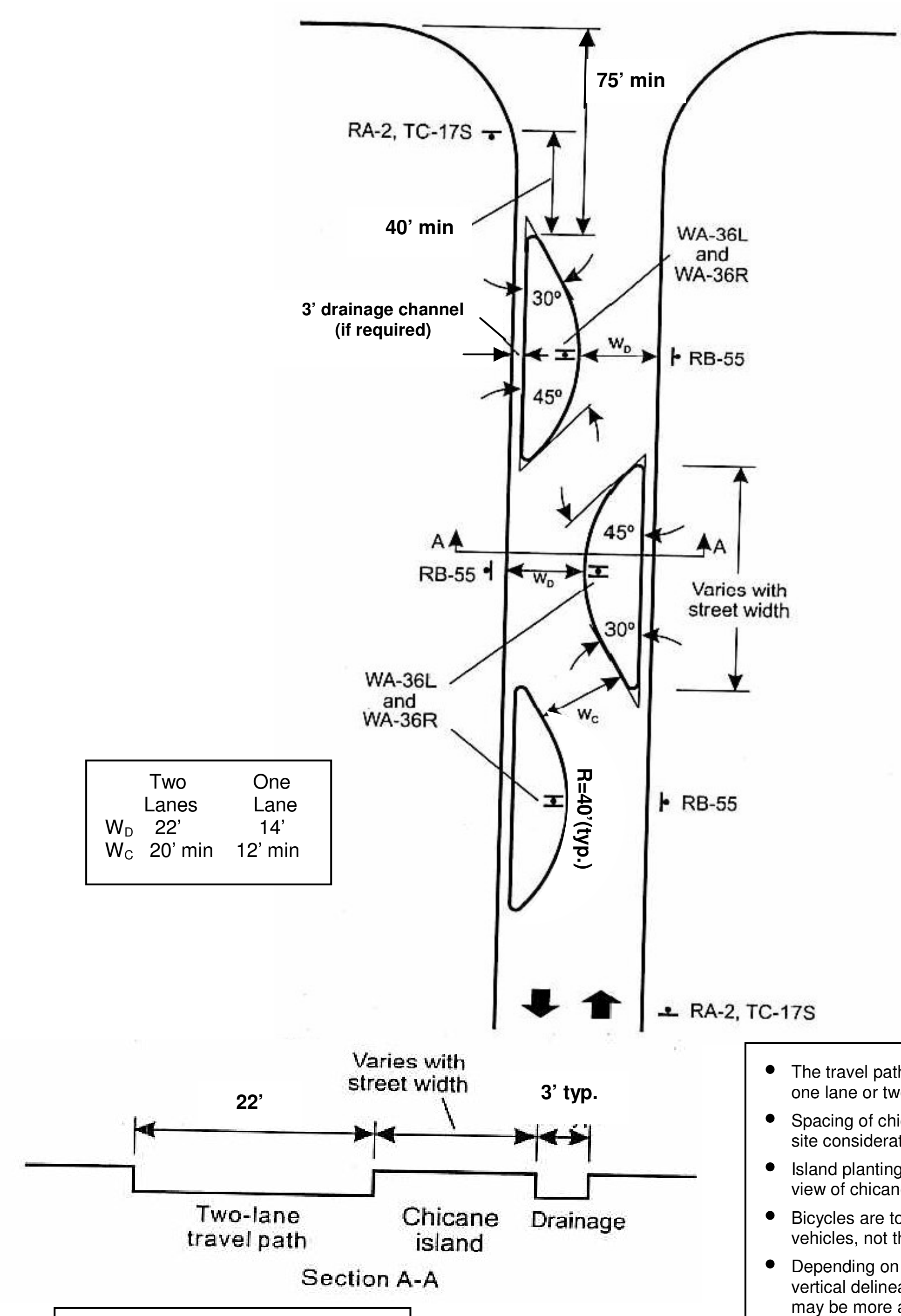
(h) Speed Table/Hump: A speed table/hump is a wide and flat undulation that is placed on a street, typically across the width of the roadway, to reduce vehicular speeds. They have a height of three (3) to four (4) inches and a length of twelve (12) or twenty-two (22) feet. Speed humps should be distinguished from speed bumps, which are much shorter (six to twelve inches long) and have been associated with maintenance, safety, and liability concerns. The speed table/hump that may be used in the City is twenty-two (22) feet long and three (three) inches high. See **Standard Drawing 3.6.3(1)h** for a typical drawing of this technique.

(i) Traffic Circle: A traffic circle is a raised, circular island that is typically placed in the center of a residential street intersection to allow traffic to flow through the intersection without being controlled by a stop sign or a traffic signal. The design of a traffic circle requires motorists to travel through the intersection in a counter-clockwise direction around the island, which reduces the number of conflict points and reduces vehicular speeds. A traffic circle creates a horizontal deflection in the roadway, which causes motorists to slow down as they travel through the intersection. See **Standard Drawing 3.6.3(1)i** for a typical drawing of this technique.

(2) Prohibited Techniques

(a) Rumble Strips: Rumble strips are raised buttons, bars, or groves that are closely placed on a roadway at regular intervals. They cause both noise and vibration in vehicles as motorists drive over them. Typically, rumble strips are used to alert motorists of unusual conditions ahead. As motorists get used to the rumble strips, the strips become less effective over time. Rumble strips can result in increased noise levels for nearby residents. Also, rumble strips require a high amount of maintenance. For these reasons, rumble strips shall not be used as a traffic calming technique in the City.

FIGURE 3.6.3(1)a CHICANE



	Two Lanes	One Lane
W_D	22'	14'
W_C	20' min	12' min

- The travel path through the chicane can be one lane or two lanes as noted.
- Spacing of chicane segments dependent on site considerations, e.g. driveway locations.
- Island plantings should not obscure driver's view of chicane traffic.
- Bicycles are to use the same path as motor vehicles, not the drainage channel.
- Depending on local climate and preference, vertical delineation other than Object Markers may be more appropriate. Possible alternatives include bollards, Delineation Markers, landscaping and curb painting.

Sign Descriptions

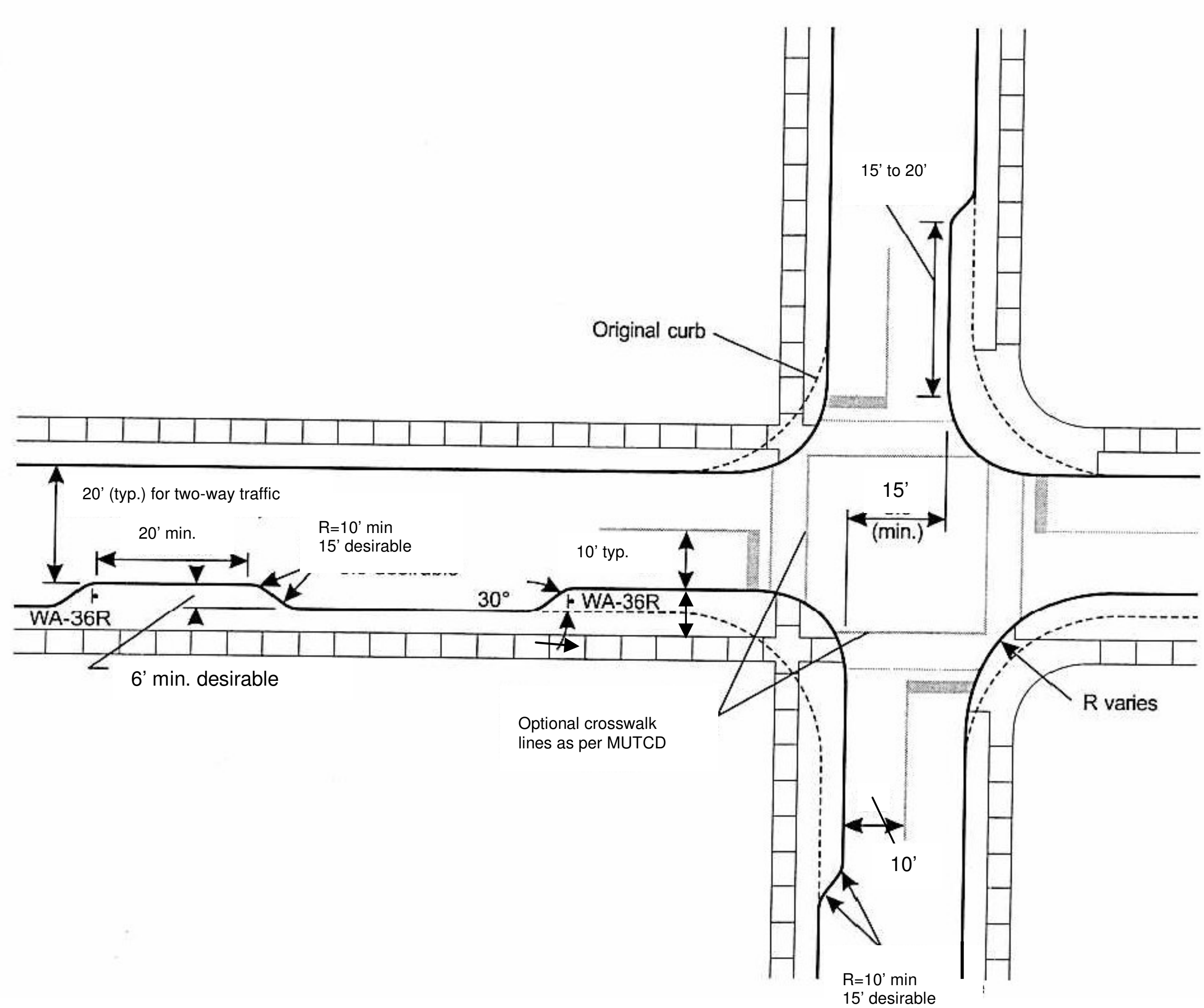
RA-2	Yield
RB-55	Stopping Prohibited
TC-17S	Yield to Oncoming Traffic
WA-36	Object Marker

NOT TO SCALE

All dimensions are in feet unless otherwise noted

Chicane
Figure 3.6.3(1)a

FIGURE 3.6.3(1)b CURB EXTENSION



Sign Descriptions:

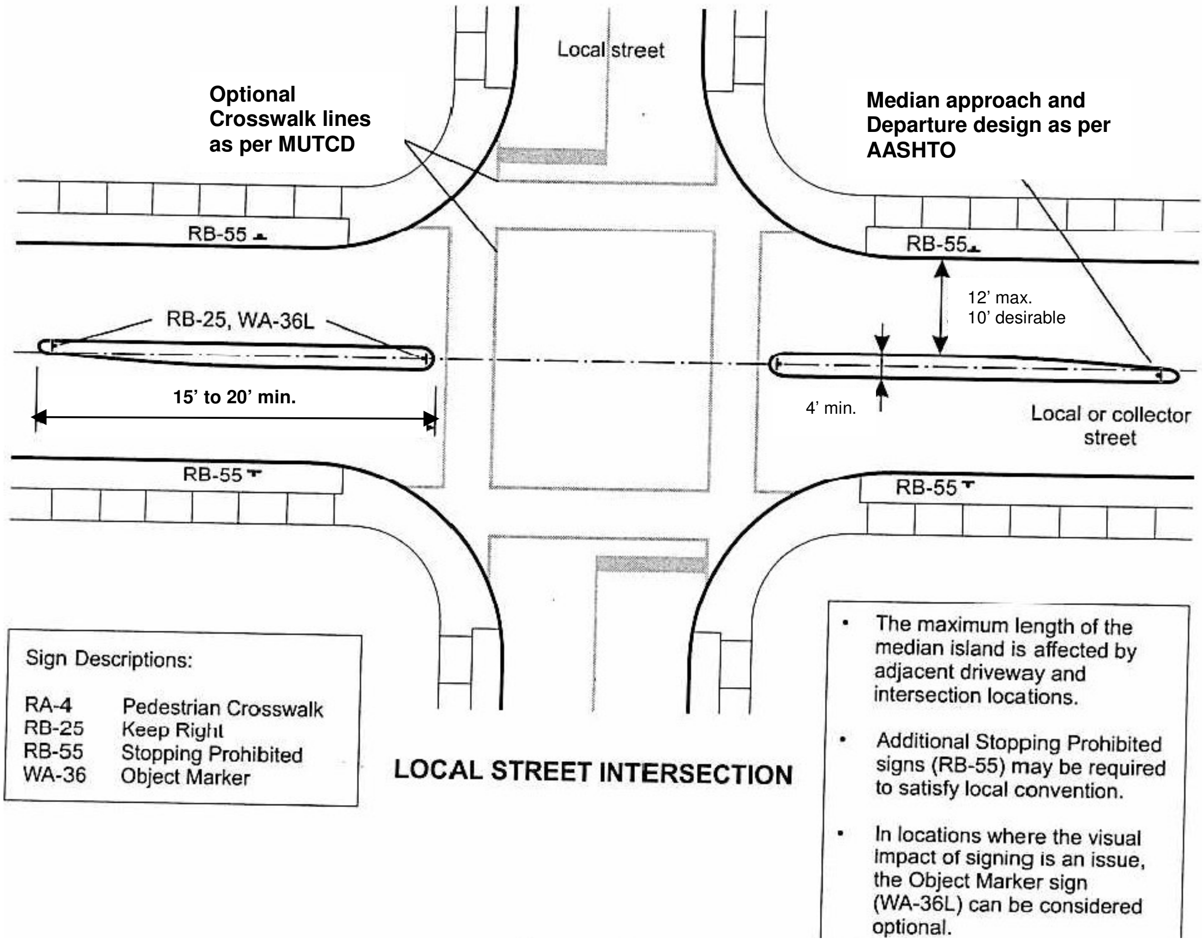
WA-36 Object Marker

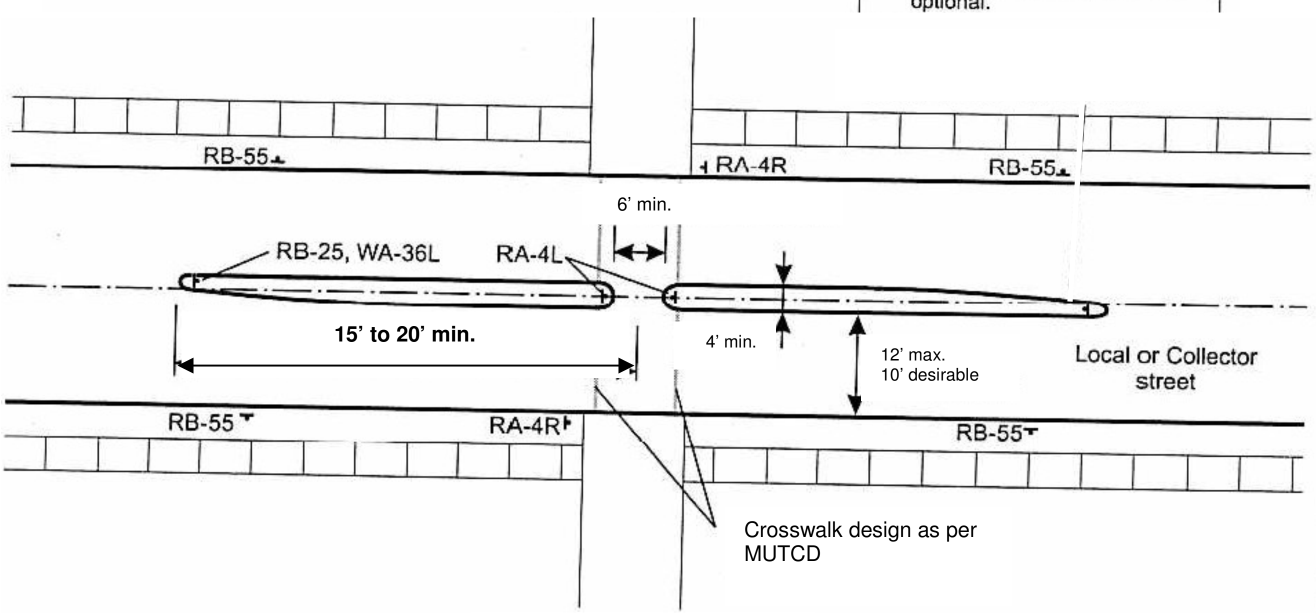
- Intersection radii should accommodate design vehicles applicable to street.
- Mid-block curb extensions should be combined with crosswalks where possible.
- Length of curb extensions must recognize site conditions, e.g., driveway locations.
- Depending on local climate and preference, vertical delineation other than Object Markers (WA-36) may be more appropriate. Possible alternatives include bollards, Delineation Markers (WA-37), landscaping and curb painting.
- II' local conditions permit, the lane widths at mid-block curb extensions can be reduced to a minimum of 2.75 m and the approach lane at an intersection curb extension can be a minimum of 2.5 m. In all instances, the minimum overall roadway width should be 5.5 m.
- If curb extensions are placed on diagonally opposite corners of an intersection, a minimum clear offset between extensions of 5.0 m should be provided to minimize vehicular conflicts within the intersection.

NOT TO SCALE

Curb Extension
Figure 3.6.3(1)b

FIGURE 3.6.3(1)f RAISED MEDIAN ISLAND



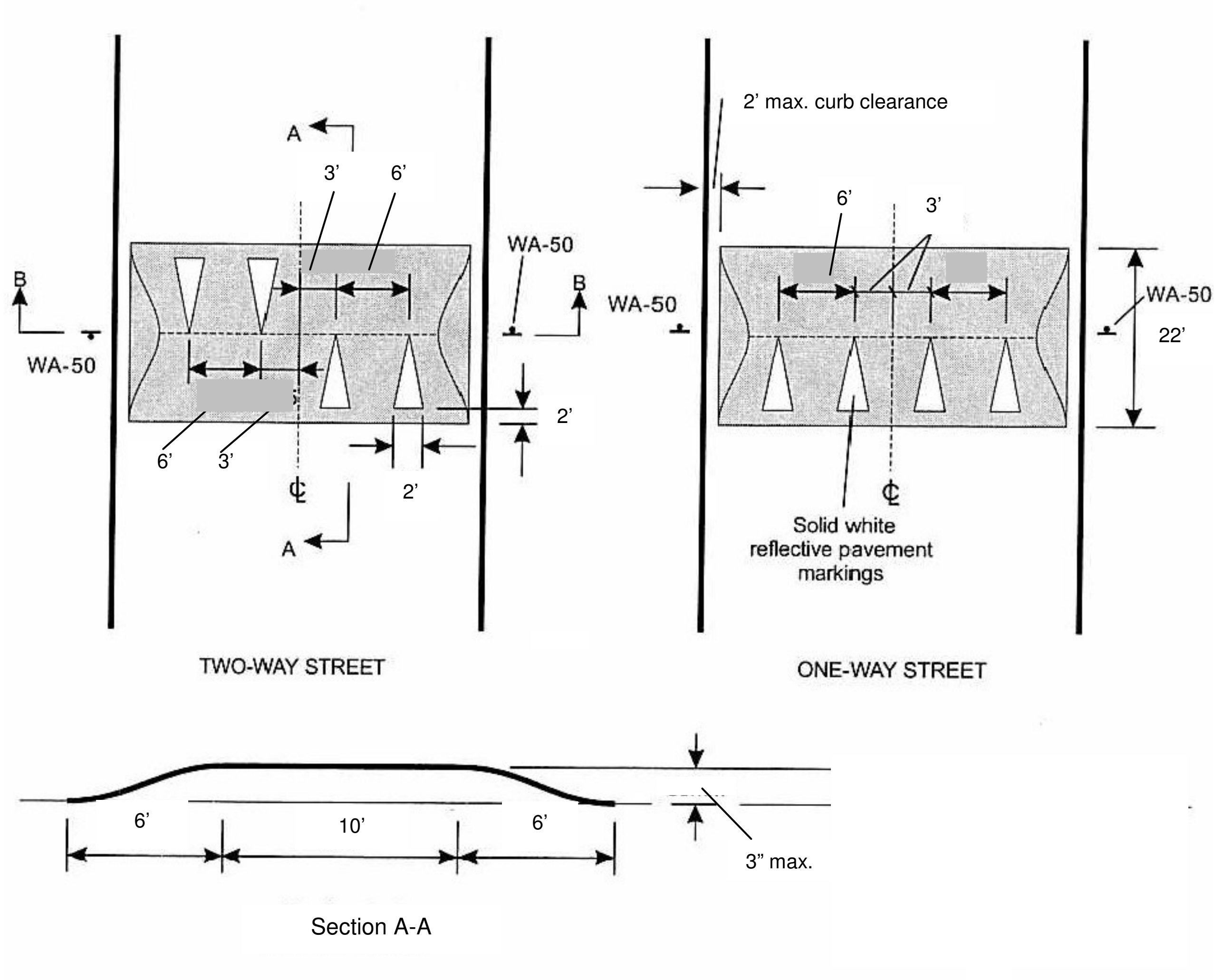


MID-BLOCK CROSSWALK

All dimensions are in feet unless otherwise noted **NOT TO SCALE**

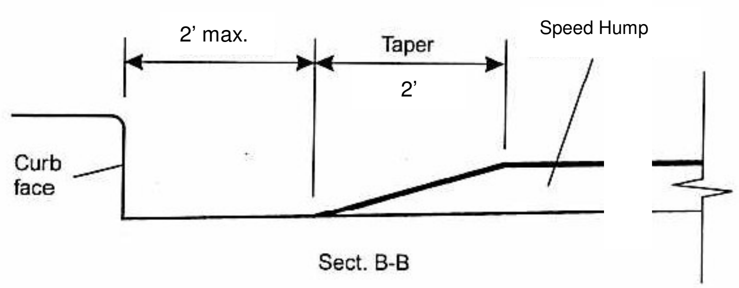
Raised Median Island
Figure 3.6.3(1)f

FIGURE 3.6.3(1)h SPEED HUMP



Sign Descriptions:

WA-50 Speed Hump

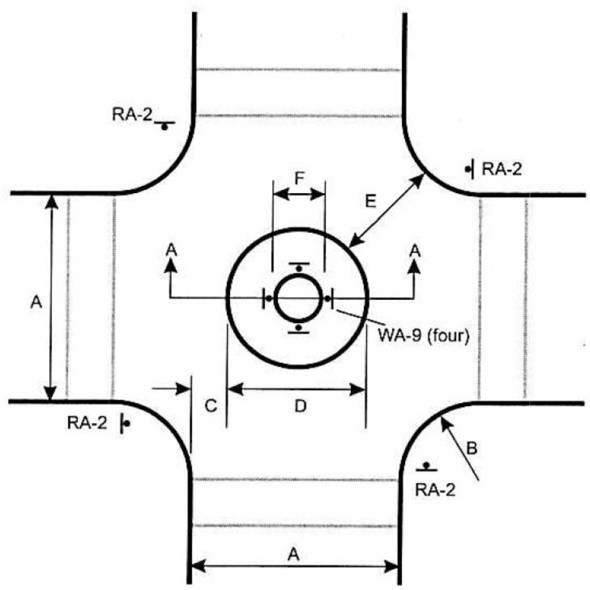


All dimensions are in feet unless otherwise noted

NOT TO SCALE

Speed Hump
Figure 3.6.3(1)h

FIGURE 3.6.3(1)i TRAFFIC CIRCLE



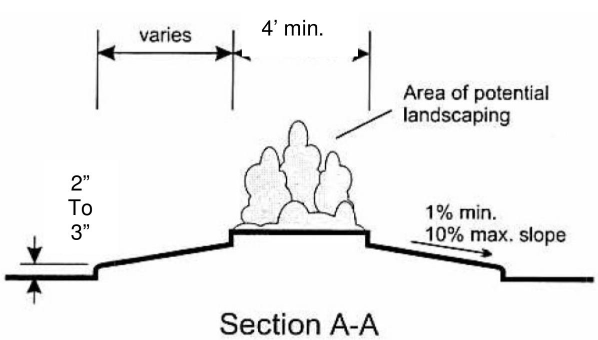
Dimension Chart for Varying Roadway Widths				
A Roadway Widths	B Curb Return Radius	C Off-set Distance	D Circle Diameter	E Min. Opening Width
20	15.5	5.5	8.5	16.0
	17.5	5.0	9.0	16.5
	22.5	4.5	10.5	18.0
	26.5	4.0	11.5	19.0
24	14.0	5.5	12.0	16.0
	16.0	5.0	12.5	16.5
	21.0	4.5	14.0	18.0
	25.5	4.0	15.0	19.0
28	12.0	5.5	15.0	16.0
	14.0	5.0	15.5	16.5
	19.5	4.5	17.0	18.0
	24.0	4.0	18.5	19.5
32	10.5	5.5	15.5	16.0
	12.5	5.0	19.0	16.5
	17.5	4.5	20.5	18.0
	22.0	4.0	22.0	19.0
	25.0	3.0	23.0	20.0
36	10.0	5.5	22.0	16.5
	11.0	5.0	22.5	16.5
	16.0	4.5	23.5	18.0
	20.0	4.0	25.0	19.0
	22.5	3.0	26.0	19.5
40	11.0	5.0	26.0	17.0
	12.0	4.5	27.0	17.0
	18.5	4.0	28.0	19.0
	22.0	3.0	29.5	20.0
44	10.0	5.0	29.5	17.0
	13.0	4.5	30.0	18.0
	17.0	4.0	31.5	19.0
	21.0	3.0	33.0	20.0

Legend:

A	Roadway Width
B	Curb Return Radius (10' min.)
C	Off-Set Distance (5' max.)
D	Circle Diameter
E	Opening Width (See Table above)
F	Raised Island Diameter (4' min.)

Sign Descriptions:

RA-2 Yield
WA-9 Chevron Alignment



Minimum Opening width to be provided to all crosswalks

A deflection triangle painted on the pavement on each approach to the traffic circle may be apppropriate.

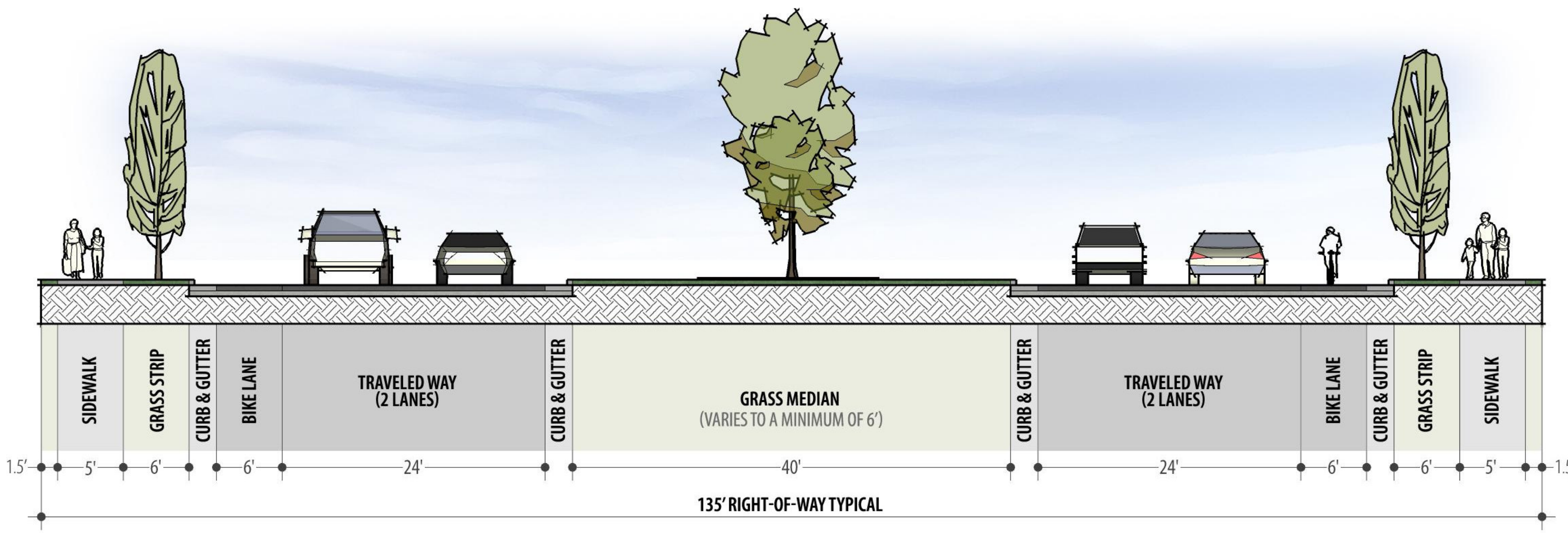
NOT TO SCALE

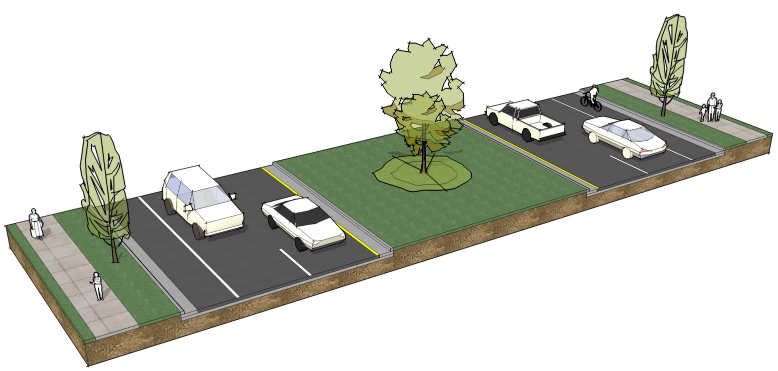
Traffic Circle
Figure 3.6.3(1)i

APPENDIX

Typical Cross Section Standard Drawings

GRESHAM SMITH AND PARTNERS





Isometric View

Notes:

Additional right-of-way may be required near intersections.

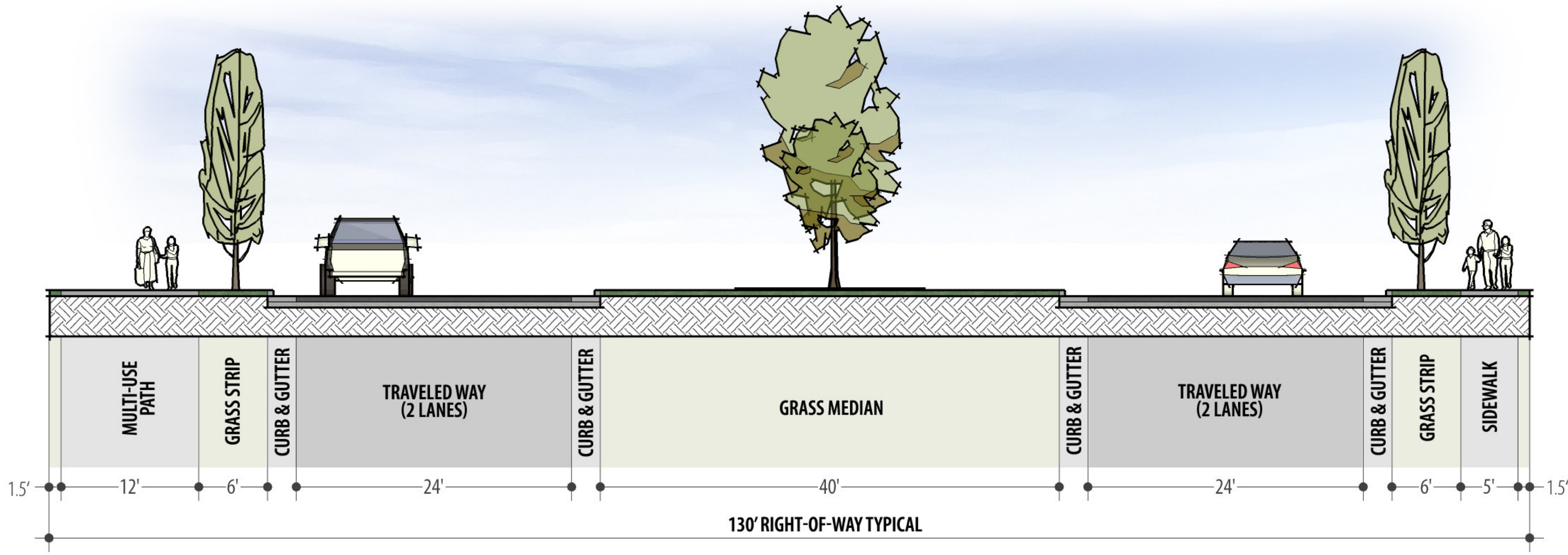
Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

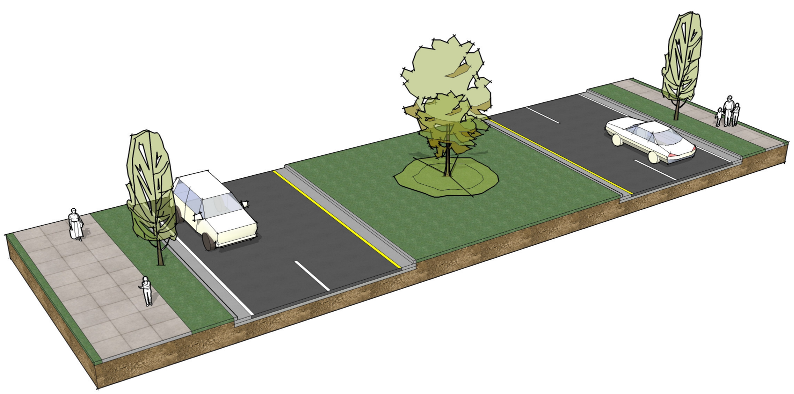
Major Arterial
135' Right-of-Way
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-1





Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

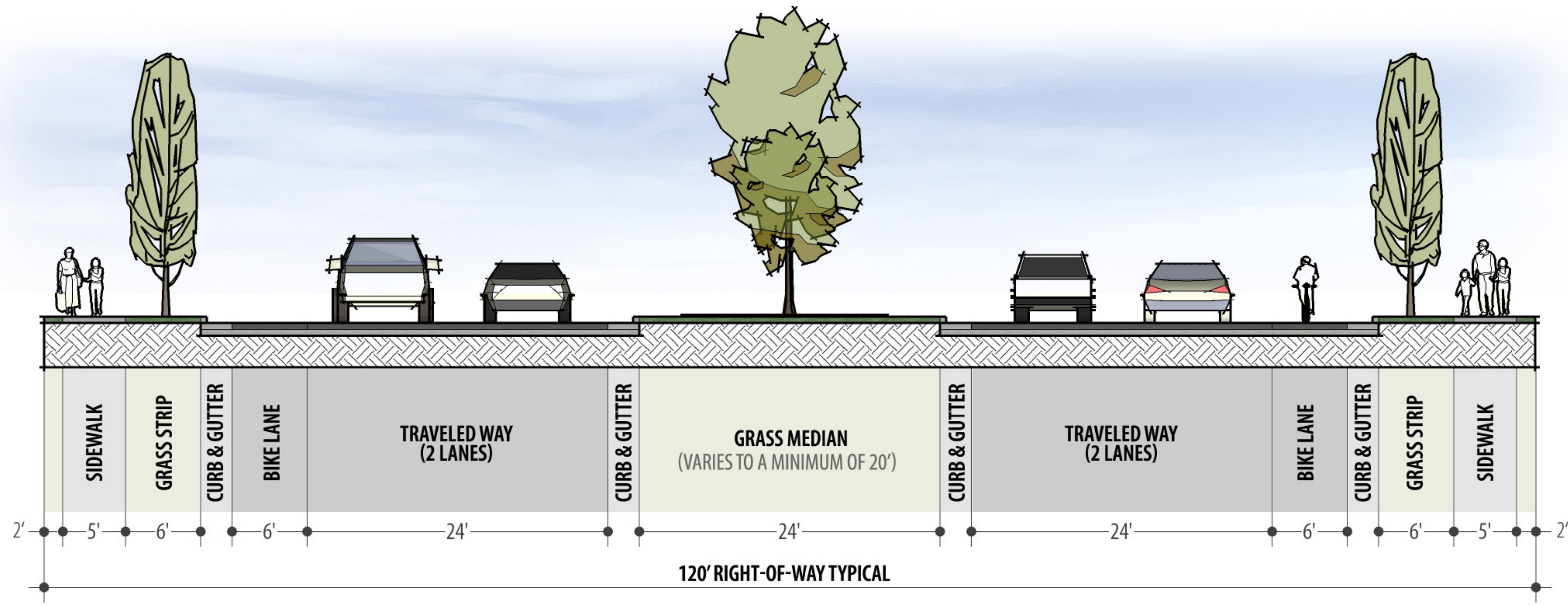
Major Arterial
130' Right-of-Way
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-2

GRESHAM SMITH AND PARTNERS



Isometric View

Notes:

Additional right-of-way may be required near intersections.

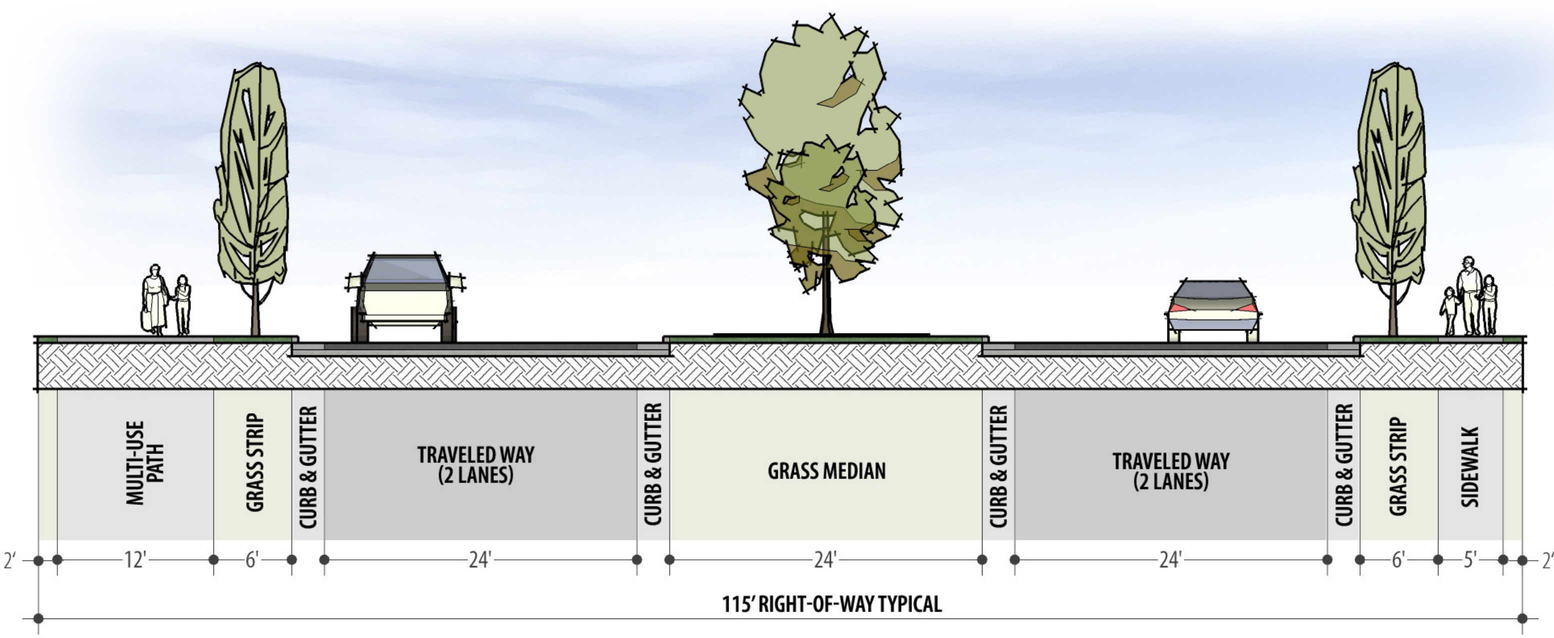
Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

Minor Arterial
120' Right-of-Way
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-3



Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

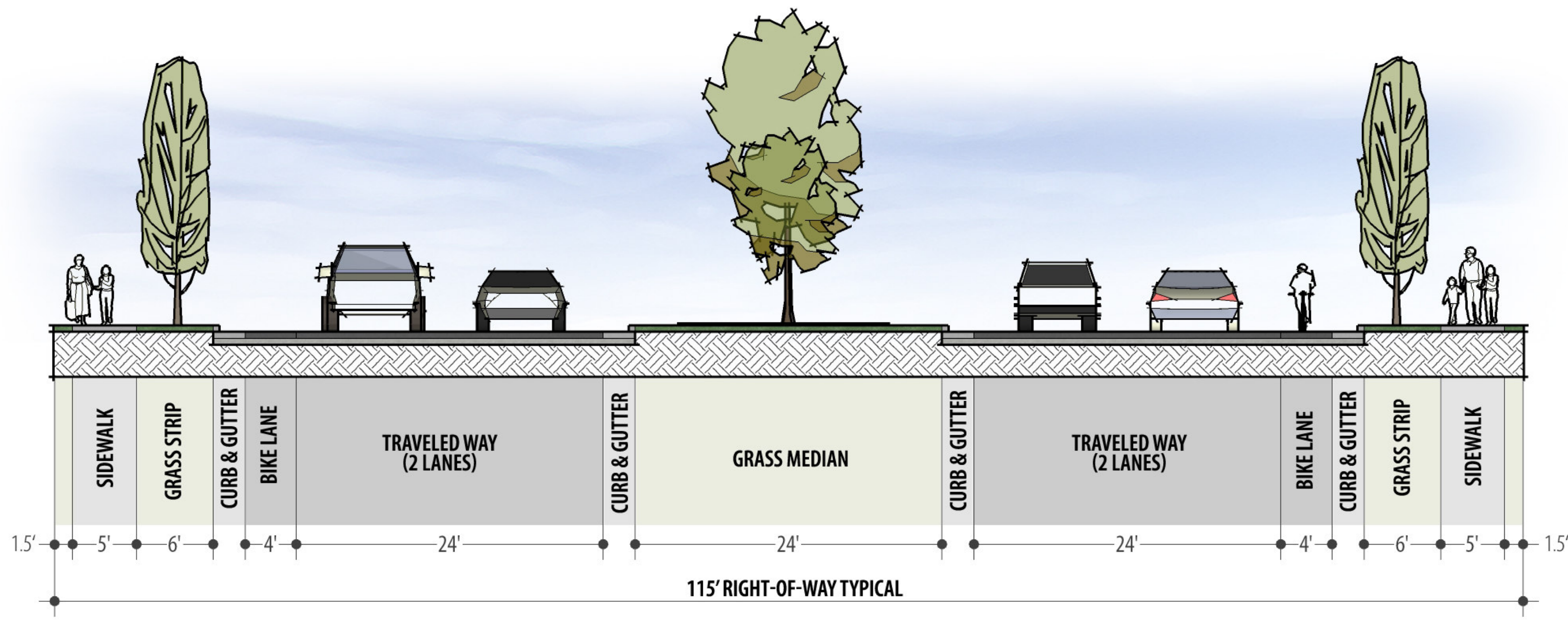
Minor Arterial
115' Right-of-Way
Conventional Areas

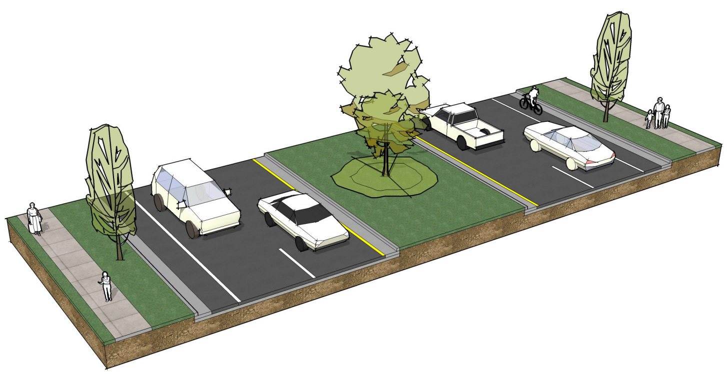
City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-4

GRESHAM SMITH AND PARTNERS





Isometric View

Notes:

Additional right-of-way may be required near intersections.

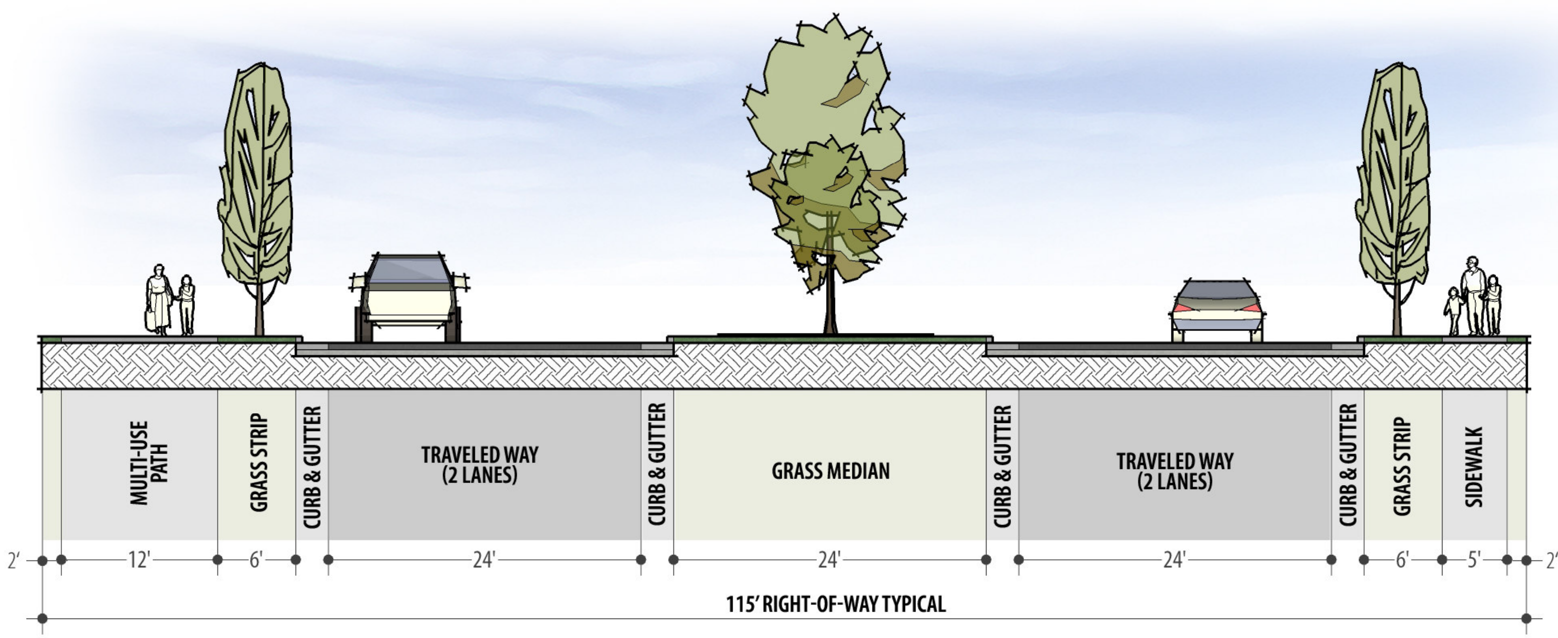
Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

Major Collector
115' Right-of-Way
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-5



Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

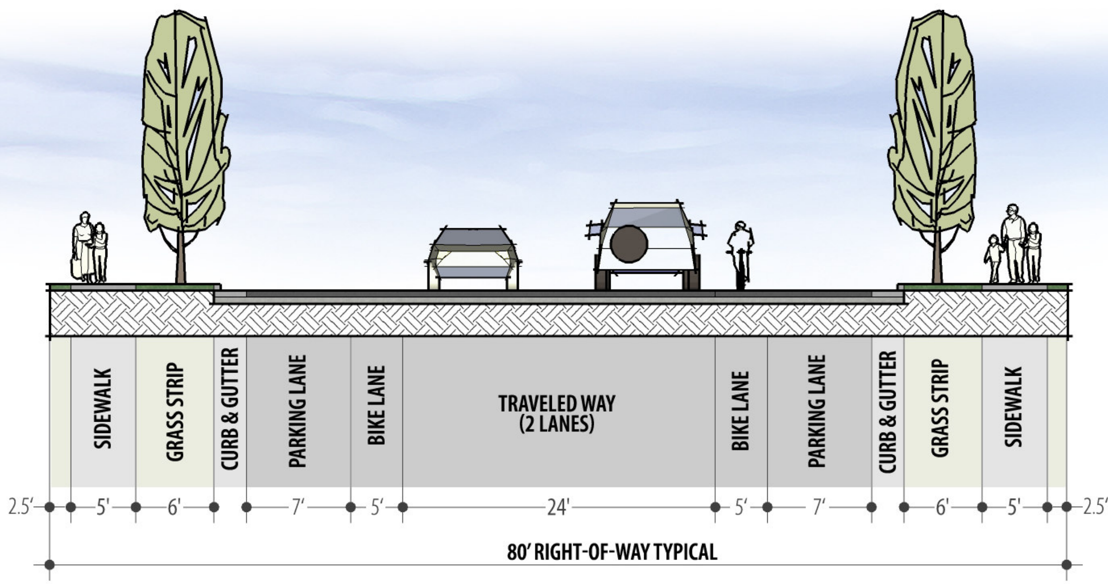
Major Collector 115' Right-of-Way

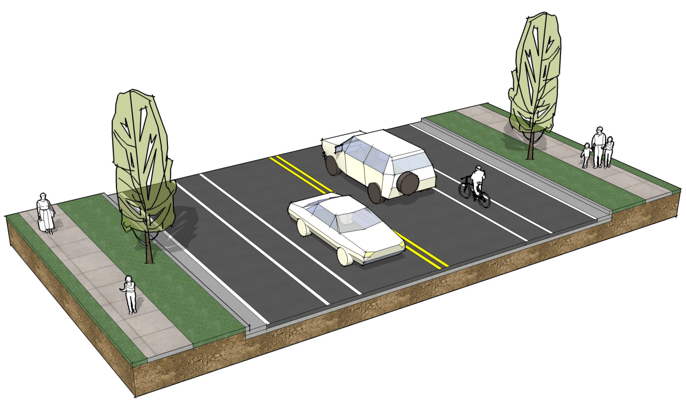
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-6





Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

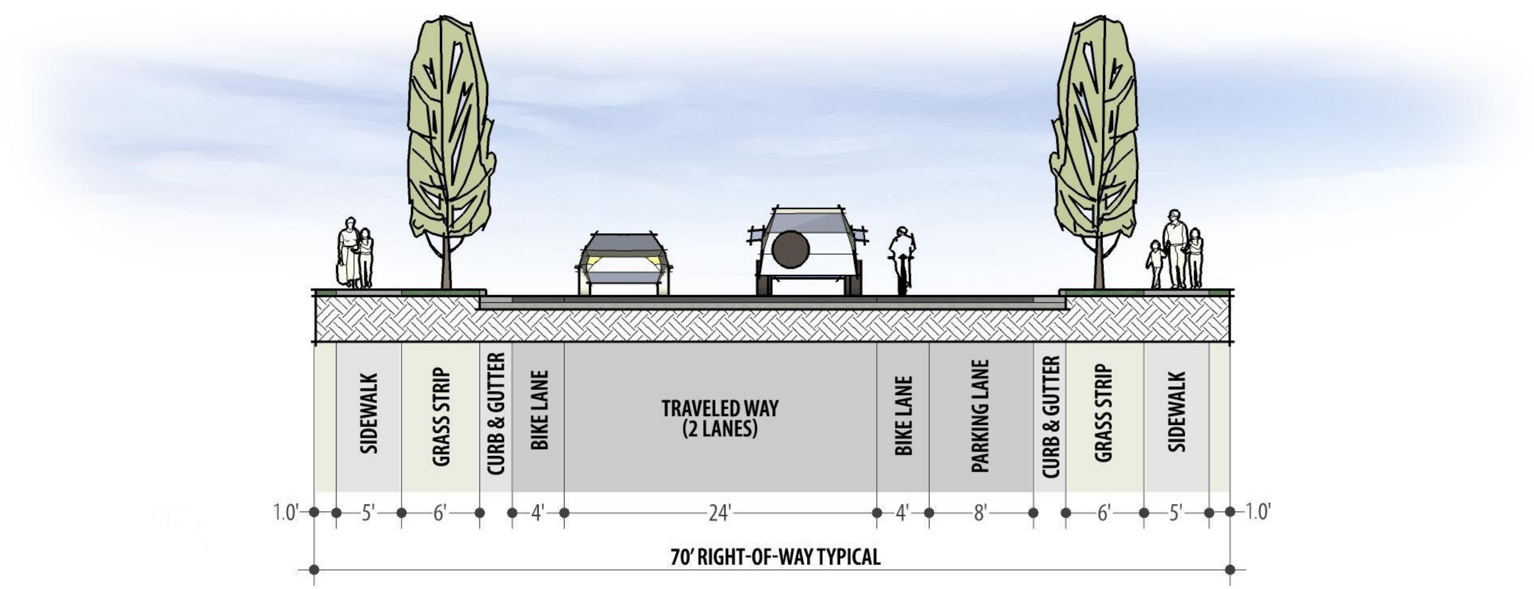
On street parking may require additional right-of-way.

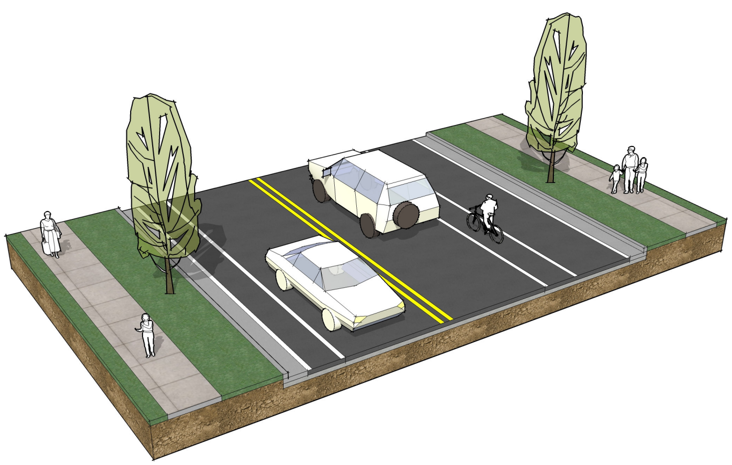
Minor Collector
80' Right-of-Way
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-7





Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

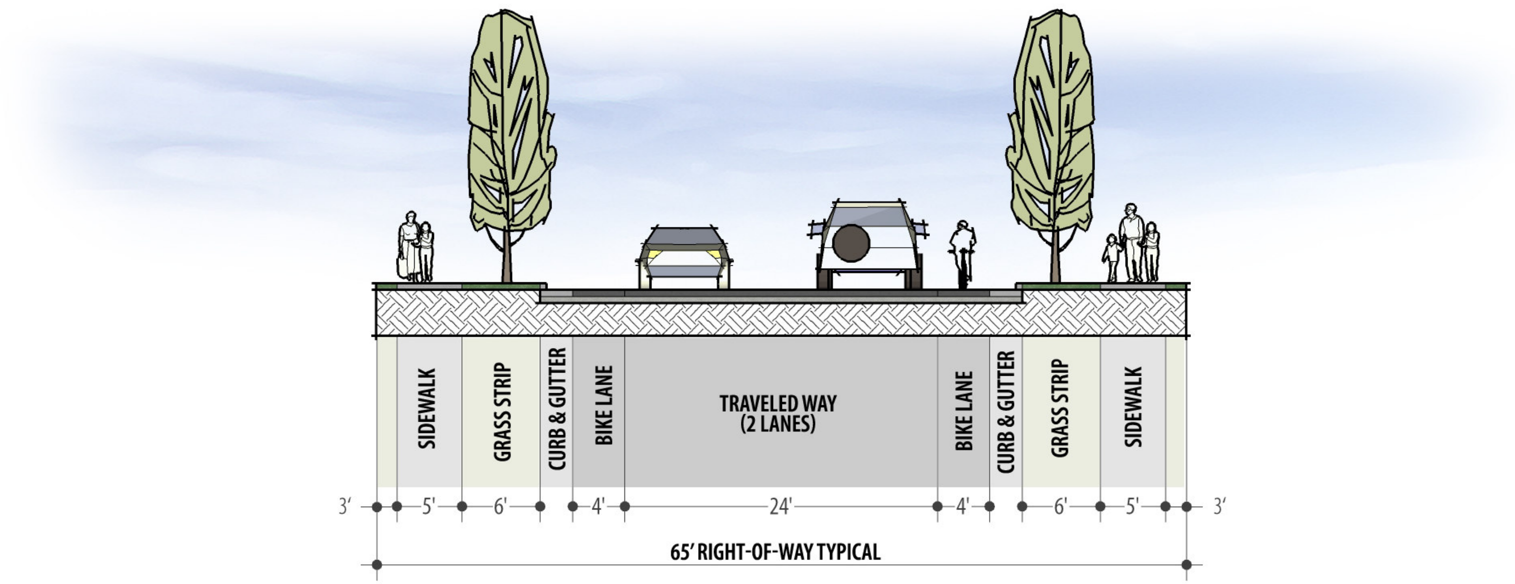
On street parking may require additional right-of-way.

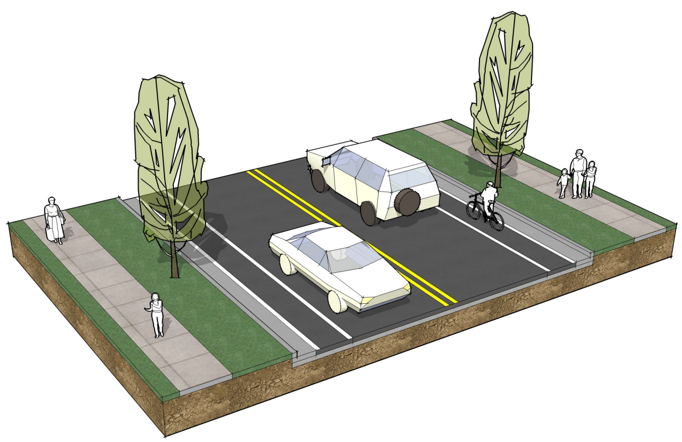
Minor Collector 70' Right-of-Way Conventional Areas

City of Franklin Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-8





Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

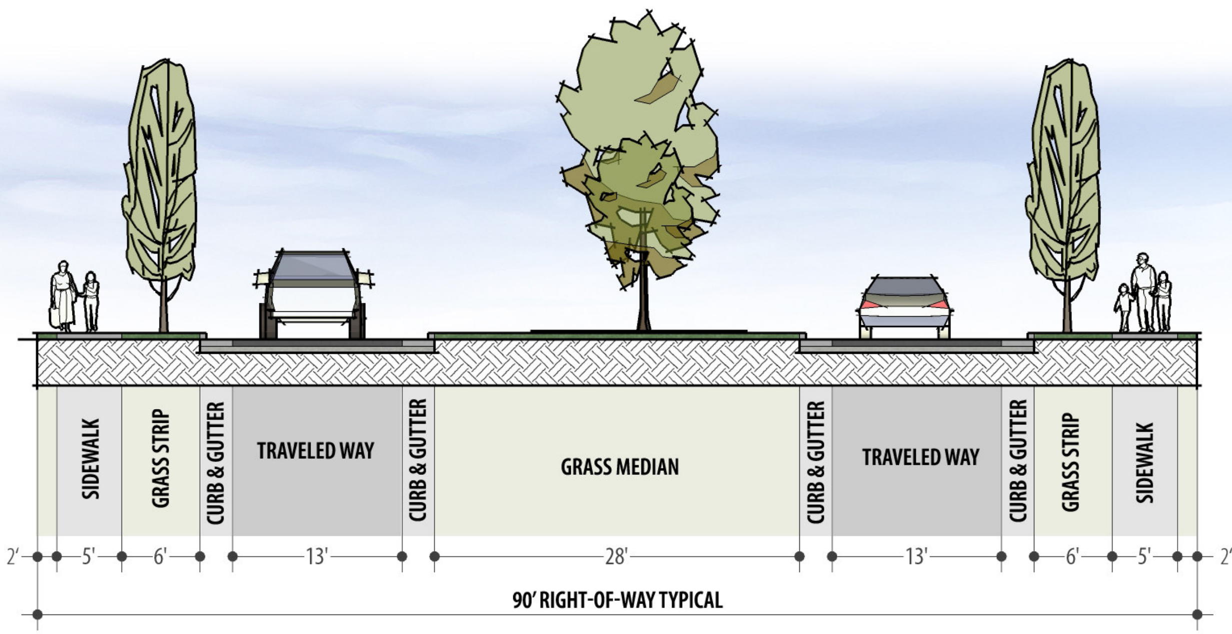
Minor Collector
65' Right-of-Way
Conventional Areas

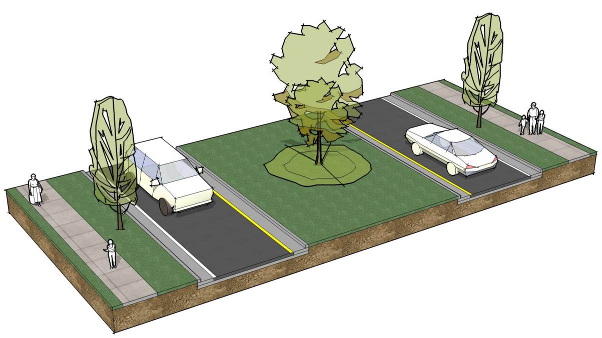
City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-9

GRESHAM SMITH AND PARTNERS





Isometric View

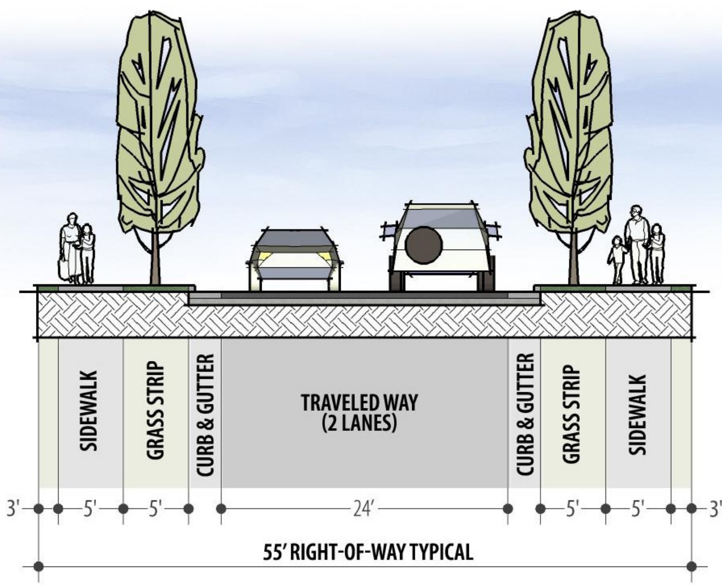
Notes:

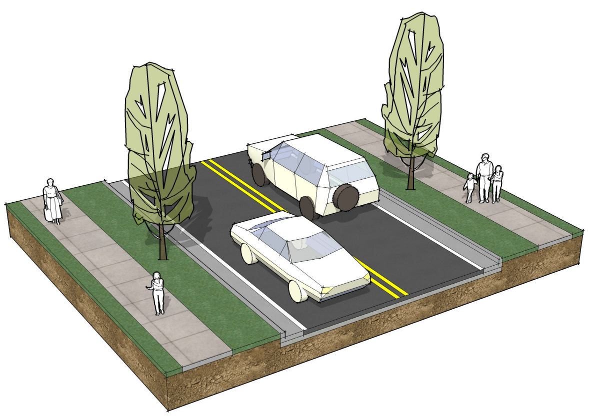
Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

Minor Collector 90' Right-of-Way Conventional Areas	
City of Franklin Engineering Department	
Date: 8/24/07 NTS	Std Dwg No: TS-10

GRESHAM SMITH AND PARTNERS





Isometric View

Notes:

Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

Local Commercial 55' Right-of-Way

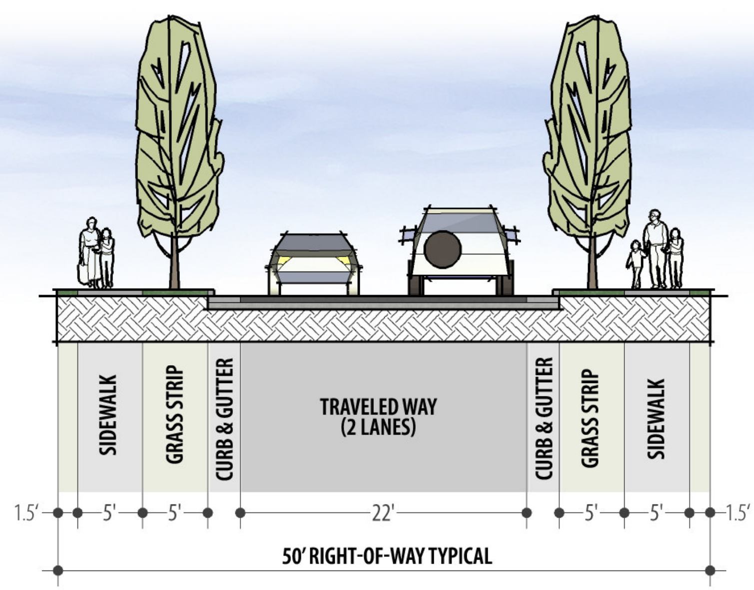
Conventional Areas

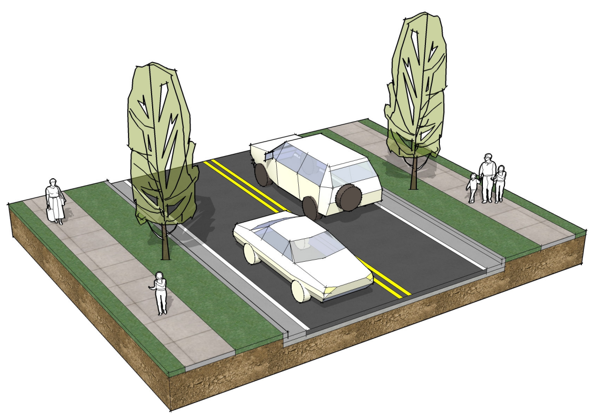
City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-11

GRESHAM SMITH AND PARTNERS





Isometric View

Notes:

Additional right-of-way may be required near intersections.

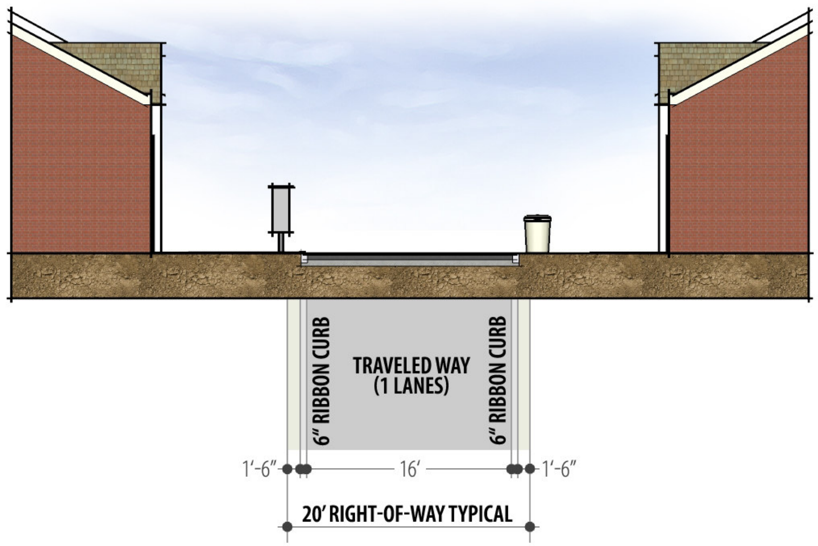
Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

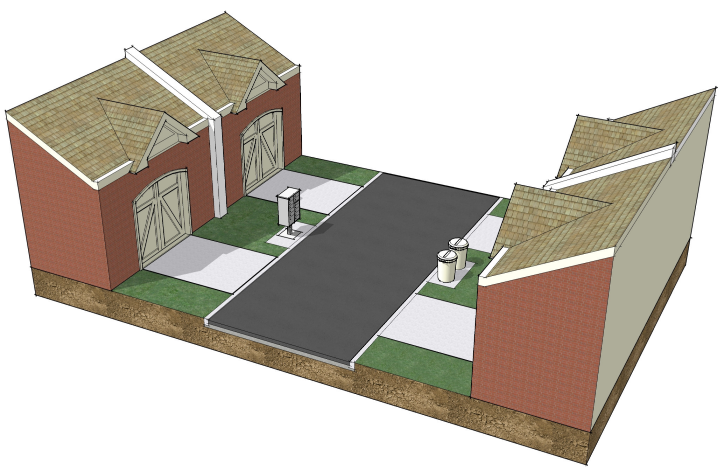
Residential Collector / Local Street
50' Right-of-Way

City of Franklin
Engineering Department

Date: 8/24/07
NTS

Std Dwg No:
TS-12





Isometric View

Notes:

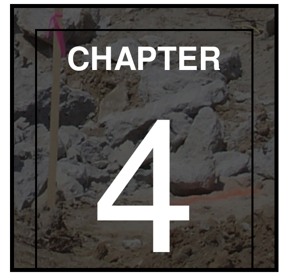
Additional right-of-way may be required near intersections.

Elements of this typical section may be revised if approved by the City Engineer in dense commercial areas.

Alley
20' Right-of-Way
Conventional Areas

City of Franklin
Engineering Department

Date: 8/24/07 NTS	Std Dwg No: TS-13



TND STREET DESIGN

4.1 - General

This chapter applies to approved Traditional Neighborhood Development (TND) and Mixed-Use Development as defined in the Franklin Zoning Ordinance. Identification of TND as a development type, or context area, is critical to the re-establishment of walking as a viable travel mode. With TND areas identified, streets can be designed to achieve the desired pedestrian, bicycle and transit usage within these designated context areas. Motor vehicle mobility is also important in TND; however, specified design elements will first encourage functional pedestrian activity and then enhance the function of motor vehicle mobility.

To facilitate a pedestrian orientation in the TND context, it is necessary to augment the conventional Arterial, Collector and Local functional classes with walkable street functional classes with generally lower speeds and corresponding design elements. These street definitions are found below.

The TND type offers another choice to the Conventional development patterns that have created most of our built environment since the end of World War II.

Properly designed TNDs should create a built environment that encourages high levels of pedestrian activity, both for destination and recreational walking. The majority of recent development is built such that recreational walking is the only walking that occurs except for those who have no other choice.

The City created this chapter for the express purpose of providing guidance for the proper development of streets in TND communities. It is critical to the success of these projects that they be designed in accordance with the following guidelines.

4.2 - Definitions

4.2.1 Conventional Suburban Development (Conventional Area)

This development type is the dominant style built since 1945, as the automobile became the dominant form of surface transportation. During this period, walking was generally understood as an outdated travel mode. Planners and engineers were correctly reflecting this prevailing American view of mobility. In addition to the impacts of the automobile, the zoning of land uses to remove residential development from hazardous industrial uses continued to separate all types of development from one another. This separated most development into single use “pods” where essentially every trip must be accomplished by the automobile.

The street system on which this development type is based consists of three classifications, arterials, collectors and locals; located in either a rural or urban setting. This system focuses primarily on providing motorized vehicle movement and accessibility.

An example of a conventional suburban development in show in **Figure 4.2.1 (1).**

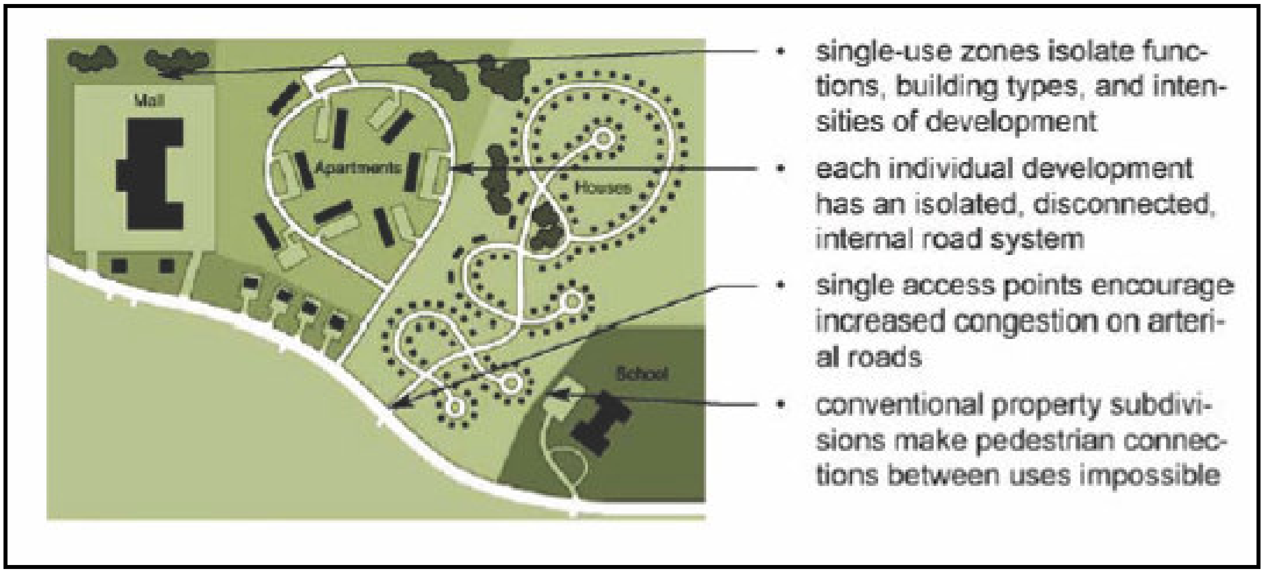


Figure 4.2.1(1): Conventional Suburban Development

4.2.2 Traditional Neighborhood Development (TND)

TND which is illustrated in **Figure 4.2.2(1)** is designed in the tradition of American villages and neighborhoods built during the nineteenth and early twentieth centuries when walking was the dominant form of local transportation.

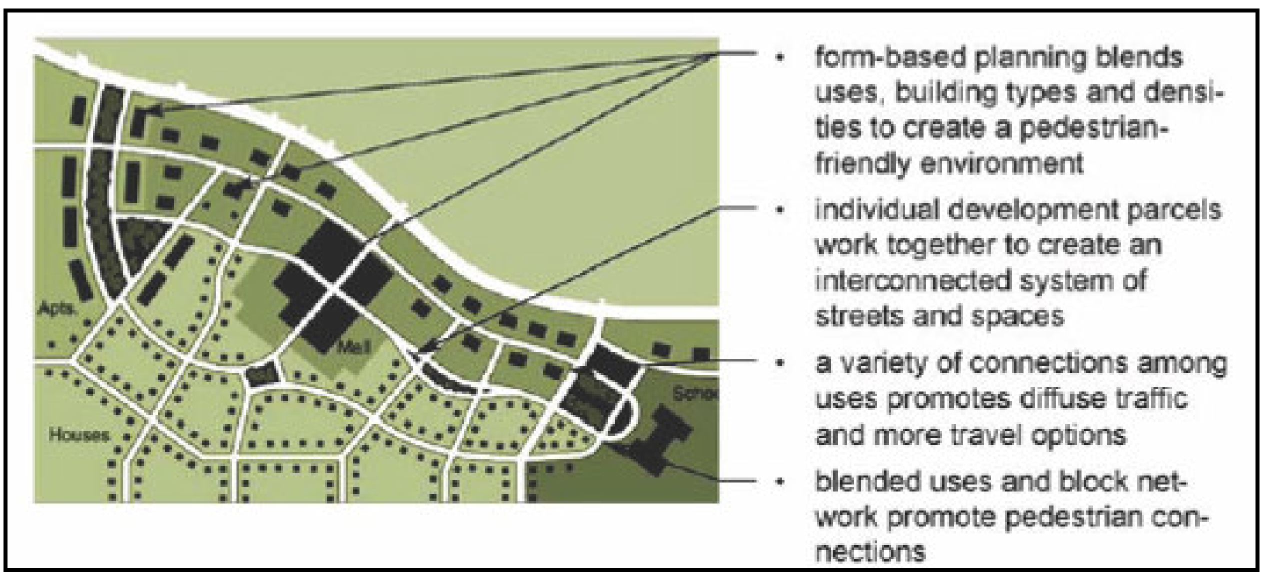


Figure 4.2.2(1): Traditional Neighborhood Development

4.2.3 Principle Elements of TND

Traditional Neighborhood Developments are intended to create communities which shall have the following principle elements:

(1) Greater Variety of Street Types within a Highly Interconnected Network
By providing a variety of street types, TND encourages a variety in neighborhood character and uses within a district. Each TND shall provide a highly interconnected street network that promotes interaction among land

uses and connectivity primarily for pedestrians with less emphasis on automobiles.

Figure 4.2.3(1): Example of a Varied, Yet Highly Interconnected Street Grid

(2) A Mix of Uses

Because a TND is designed to create a form where people are less dependent on cars, each neighborhood should have a mix of uses that serve the neighborhood such as schools, churches, services, shopping, entertainment, and offices, in an amount appropriate to the size and population of the community.

Figure 4.2.3(2): Mixed-Use Neighborhood

(3) Institutions or Neighborhood-Serving Commercial as Focal Points

Neighborhood serving community focal points such as retail stores, schools, services, and parks should be within walking distance of the majority of dwelling units within a neighborhood. Typically a walkable distance is considered to be between a five and ten minute walk, as illustrated in **Figure 4.2.3(3)** below. Small mixed-use districts at key intersections, a public plaza surrounded by live/work units, or a school with community and recreation facilities are examples of design elements that serve as community gathering spaces and focal points for TND.

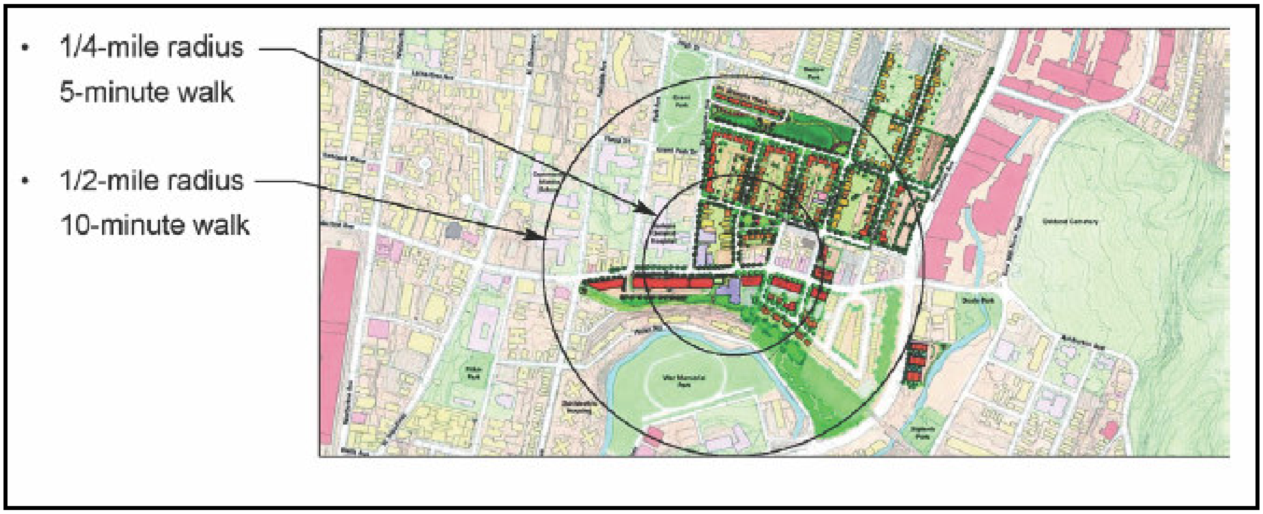


Figure 4.2.3(3): Neighborhoods Should be Served by a Village or Town Center

(4) Pedestrian-and Transit Orientation

TND shall be designed to improve the pedestrian experience by providing smaller block sizes, streets, lower vehicle speeds, buildings at the back of sidewalk, generous sidewalks, on-street parking and protection from the elements through use of street tree and awnings. By reducing the crossing distance at pedestrian crossings and removing driveways from front yards through the use of alley loaded lots, vehicle/pedestrian conflicts are minimized, significantly improving safety for the pedestrian.

Blocks should be sized to support high levels of pedestrian activity. Pedestrian mobility increases with blocks that are a maximum of 600 feet in length or approximately 220 feet in width.

Figure 4.2.3(4): Properly Designed Pedestrian Space

(5) An Interconnected Network of Open Space

An interconnected network of public open space is an essential component to be provided in a TND. A network of open spaces encourages interaction among neighbors and reinforces strong pedestrian and bikeway connections.

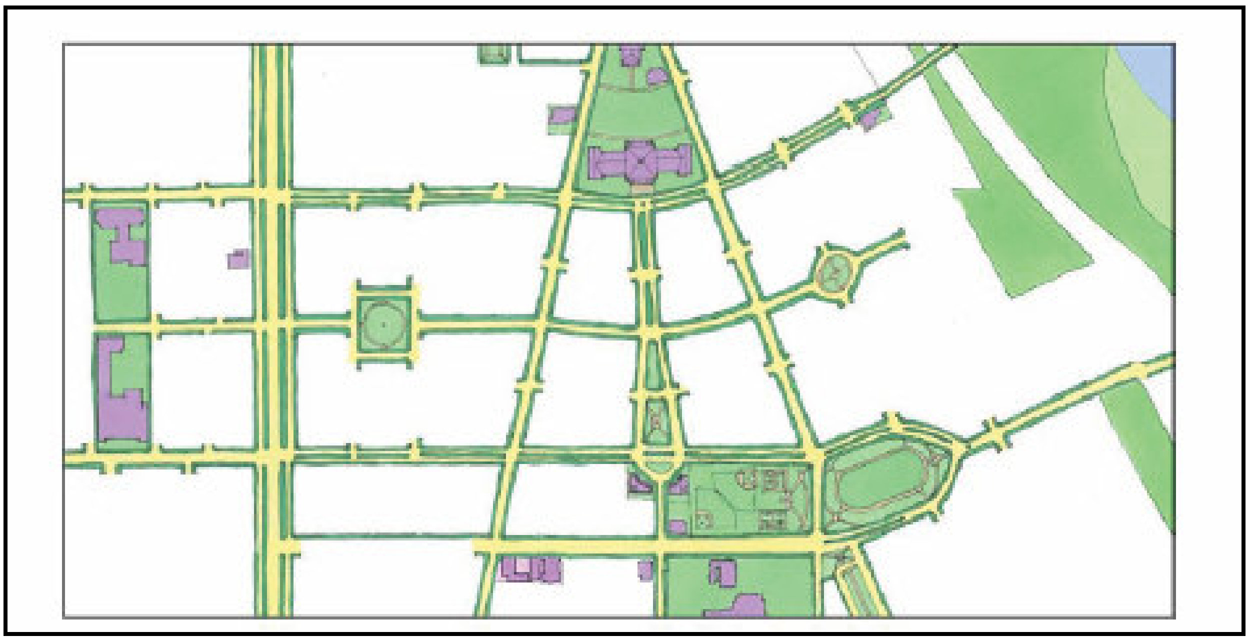


Figure 4.2.3(5): Boulevards, Neighborhood Parks and Institutional Site Form a Network of Open Space

(6) Use of transect zones to organize space and determine design criteria.

The design of a TND street, building, or other element is not consistent over the entire TND. Some types of design are appropriate in one portion of a TND but not in another. In a TND, the appropriate design depends on the extent to which an area is more urban or less urban. Designers use the transect zone system to delineate the distinct areas of a TND according to this more urban/less urban context.

Within the transect zone system, a T-1 transect represents the least urban area. A T-6 represents the most urban area. The T-2 through T-5 transects represent the design contexts in between. A description of each transect type is included below:

T-1 – Rural Preserve: These are lands that are permanently out of development, such as protected wild lands or parks.

T-2 – Rural Reserve: These are lands that are currently not in development, but may be put into development in the future. Examples might be farmland on the outskirts of a town, or a forest that is being managed for silviculture today but could be built upon in the future.

T-3 – Suburban: This area includes lower density development, with minimal levels of mixed use, primarily single-family housing.

T-4 – General Urban: These areas have urban-scale densities and intensities of use. Housing types include a mix of single – and multi – family, including row houses, town homes, and other urban housing types.

T-5 – Town Center: A high-intensity center area with a wide mix of uses, including housing over shops and multi-story retail.

T-6 – Core: Very high-intensity areas with a very wide mix of uses. These are the most urban areas, comparable to a central business district.

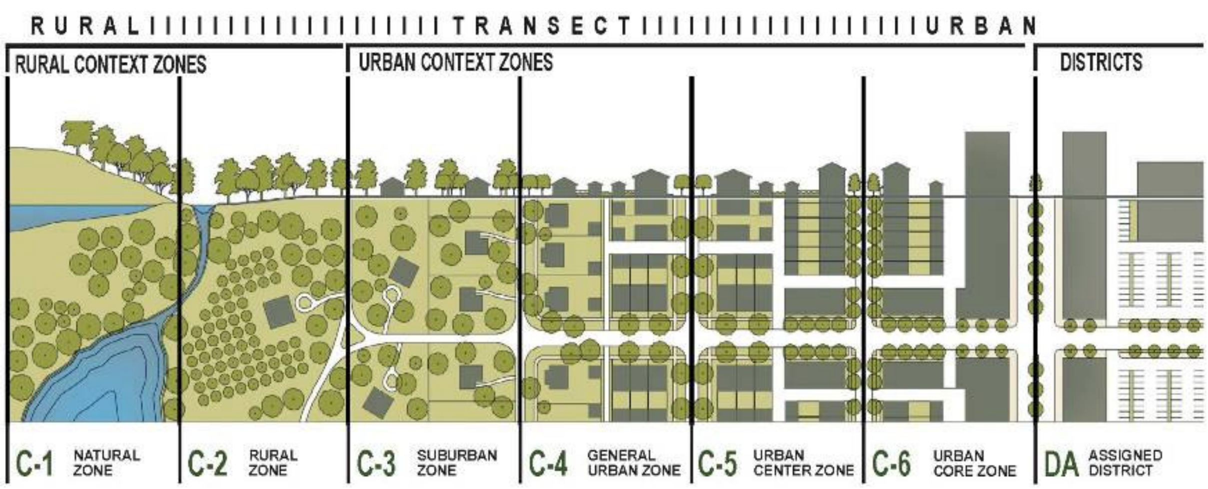


Figure 4.2.3(6): Transect Diagram (C- designations are used interchangeably with T-)
Source: Duany Plater-Zyberk and Company

4.3 - Street Planning and Design

Public street design for TND shall conform to the arrangement, width, and location standards specified in this chapter and appropriate references contained herein.

4.3.1 Street Grids

In instances where a new street is not indicated on the Major Street Plan, it should support a rectangular grid or modified grid street network to the maximum extent practicable. Curvilinear street networks should only be used when:

(1) Topographic or environmental constraints make use of the grid pattern infeasible;

(2) Established development patterns on adjacent lands make the grid pattern infeasible;

(3) They may be used in conjunction with a grid pattern to limit exceptionally long vistas exceeding 1,200 feet down straight streets.

4.3.2 Block Length

Except in cases where environmental or topographic constraints exist, or the property has an irregular shape, no individual block face (linear feet between the right-of-way edges of intersecting streets) shall exceed a maximum length of 600 linear feet.

4.3.3 Block Width

To the maximum extent practicable, the width of any block shall be sufficient to permit at least two tiers of lots of appropriate depth for the zone district exclusive of any public alleys, watercourses, or other rights-of-way located outside platted lots. This standard shall not apply to areas that contain steep slopes where it is more desirable to reduce environmental impacts.

4.3.4 Internal Mid-Block Pedestrian Access

In exceptional cases where a block length exceeds 600 feet, sidewalks in easements or on open space lots should be considered mid-block to connect parallel streets on the long side of the block.

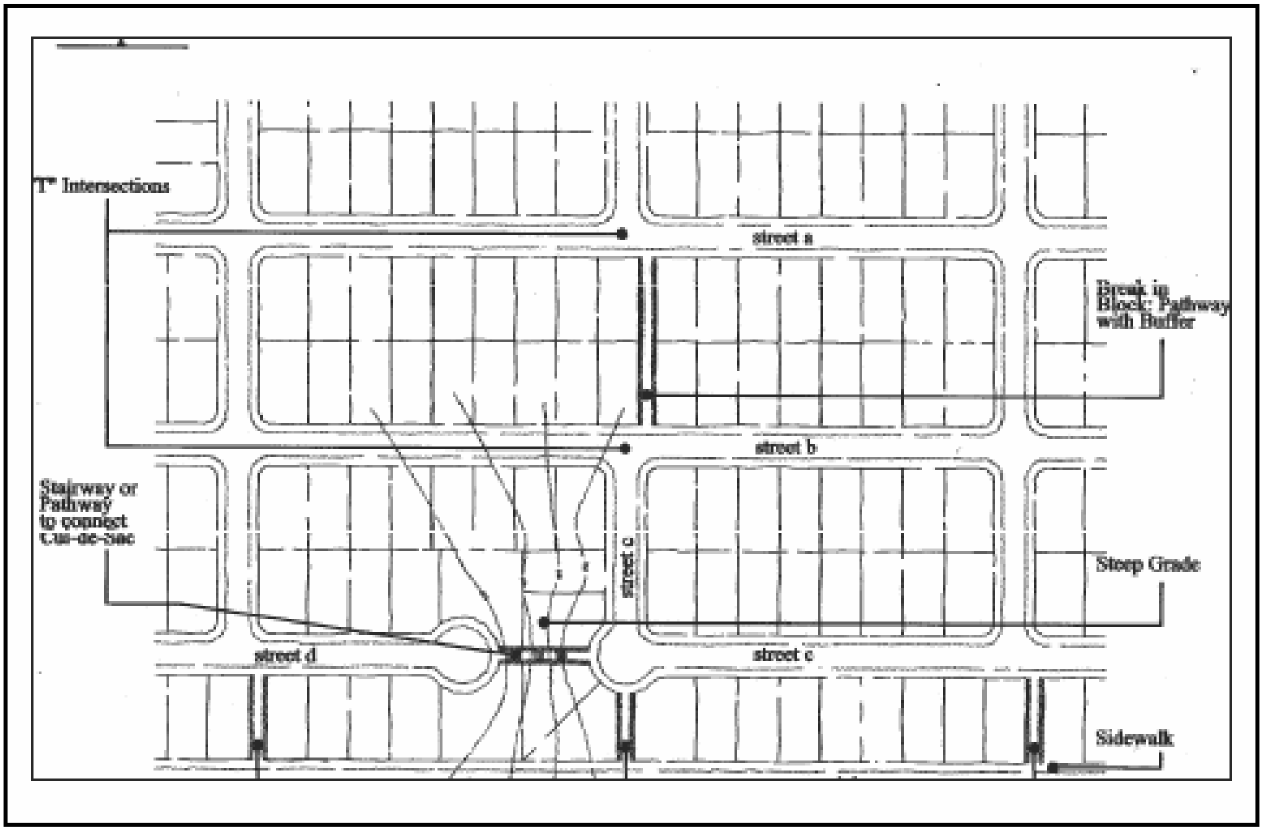


Figure 4.3.4(1): Mid-block Pedestrian Accessways (as indicated by the darker lines) Help Maintain Pedestrian Access within Long Blocks

4.3.5 Minimum Street Standards

Streets in conventional areas shall follow the conventional street designations as described in the **Chapter 3, Street Design**, using the conventional arterial, collector, and local designations. In TND areas, however, streets will be designated using different classification and design standards. As shown in **Table 4.3.5**, eight distinct street types are designated. Within each Street type, there is a range of variability in standards available to designers to meet the particular context and demands of a given site. This range of designated street types allows TND areas to function with safe, comfortable, and attractive pedestrian mobility, while also providing for automobile transportation and parking needs. Examples of each street type are provided below.

Speed management is the critical factor in the design of traditional area streets. TND streets can be classified according to one of the following “movement types”. Movement types describe expected driver free flow speed on a given street. The design speed for pedestrian safety and mobility is the determinant for each of these movement types. For TND street design, the design speed is at least the value of the posted speed.

4.3.6 Movement Types

YIELD: Drivers must proceed slowly and with extreme care and must yield to pass an approaching vehicle. This provides the functional equivalent of conventional traffic calming.

SLOW: Drivers can proceed carefully with an occasional stop to allow a pedestrian to cross or another car to park. Character of the street should make drivers more aware of the presence of parked cars, enclosure of buildings, smaller turn radii, and other design elements.

FREE: Drivers can expect to travel generally without delay in off peak conditions; street design supports safe pedestrian movement at these higher design speeds. This movement type is appropriate for streets designed to traverse longer distances or connect to higher intensity locations.

SPEED: Drivers can expect travel similar to conventional street design, but with continued emphasis on pedestrian safety and comfort.

RURAL: Conventional street design in which drivers can expect a separation of modes - e.g., bike lanes, walking paths, and roads -- allowing automobile travel unimpeded by lateral pedestrian movement. This movement is rarely used in traditional town planning but may be needed when traveling through T-1, T-2, or T-3 transect zones.

The movement type for each street is indicated in Table 1. The design speed and transect zone determine critical design elements including curb radii, travel lane width, and parking lane width.

Table 4.3.5: Street Types - Franklin TND Street Design Guidelines

Street Type	Design/ Posted Speed	Movement Type	Context/ Transect Zone	ROW	Travel Way	On-street Parking Width & Sides Parked	Curb Radius	Plantings	Sidewalk Width
Alley (CA)	15	Yield	Commercial/T4-T6	20'	16'	NA	15'	NA	NA
Yield Street (YS)	25	Yield	Residential/T3-T4	50'	2 lanes 10'	unmarked but allowed	15'	6' strip min	5' min, both Sides
Street (ST)	25	Slow	Residential/T3-T4	55'	2 lanes 10'	8' both sides	15'	6' strip min	5' min, both Sides
Drive (DR)	25	Slow	Residential/T3, T4, T5	60'	2 lanes 10'	8' both sides	15'	Tree wells or planters	5' min one side, 10' other
Town Street (TS)	25	Slow	Commercial/T4-T6	65'	2 lanes 11'	8' both sides	15'	Tree wells or planters	8' min
Main Street (MS)	25	Slow	Commercial/T4-T6	60'	2 lanes 11'	8' both sides (angle opt)	15'	Tree Wells	10' min
Avenue (AV)	25	Free	Commercial/T4-T5	Varies, per central median or park feature	2 lanes 11'	8', both sides	15'	Tree wells or planters	8' min
Boulevard (BV)	30	Speed	Commercial/T5-T6	Varies, per central median or park feature	4 lanes, 11' Side Access Streets 19' including 8' parking	8', both sides	20'	Tree Wells or planters	8' min

Notes:

1. All Travel Way widths are actual asphalt width. Gutters are 2' wide and not included in travel width.
2. "Transect Zones" based on the SmartCode™ describe type of development intensity based on a continuum of urban to rural, with T-6 as "urban core" and T-1 as "rural preservation".
3. Use driveway-type connection of alley and lane to street
4. All street types are for two-way traffic – one-way streets encourage wrong-way bicycle riding and higher automobile speeds
5. Additional street types allowed per design requirements
6. Street type naming convention: Type of Street (ST, DR, AV, etc.); ROW; Pavement width (travel lane plus parking); lane configuration, Example: ST 54 30 7/8/8/7 is a street with 54' ROW, 30' pavement curb face to curb face, configured as a 7' parking lane, two 8' vehicle lanes, and another 7' parking lane.
7. Typical service vehicles to maneuver curb radius without going up onto curb. Vehicles may cross into opposite lane. Parking to be limited at intersections to accommodate turning movements.
8. Angled parking will require more ROW for Main Street types.

4.4- Typical / Conceptual Street Sections

Typical/Conceptual street sections for each street type are shown below. As each street type in **Table 4.3.5** actually describes a range of possible sections, the illustrations below indicate a possible street section, not a required section. This flexibility allows TND designers to use their own judgment and professional expertise in crafting TND streets, consistent with **Table 4.3.5**. Alleys are used in residential and commercial areas and are intended to be very utilitarian and urban in character.

4.4.1 Conceptual Alley Layout

(1) Typical Cross Section
The typical cross section for an Alley is shown in **Figure 4.4.1(1)**.

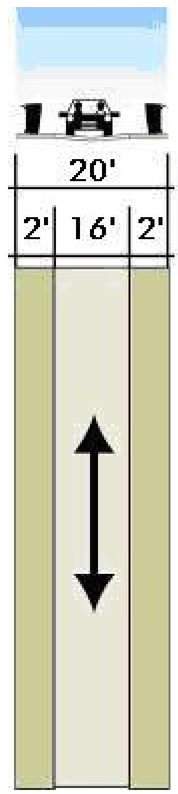


Figure 4.4.1(1): Typical Alley Section

(2) General Standards
Developments that utilize alleys shall comply with the following standards:

(a) Designers shall ensure that garbage and utility service can be served from alleys in developments where services are provided. Designers must be able to demonstrate to the City through analysis that City equipment can maneuver through intersections involving Alleys.

(b) Mailboxes should be located in mailbox gangs in locations that do not conflict with turning operations of school buses, emergency services, garbage collection and utility service vehicles.

(c) Mailboxes shall be located to avoid conflicts with garbage collection operations.

(3) Residential Development
Residential Alleys shall be required to serve detached residential lots with a lot width of 50 feet or less and attached dwellings, except where topographic or environmental constraints make use of alleys infeasible.

Figure 4.4.1(2): Residential Alleys Allow Service Functions to Occur at the Rear of Dwellings and Reduce the Impact of Cars, Driveways and Garage Doors on Streets

(4) Nonresidential and Mixed-Use Development
Commercial Alleys are required for commercial development to provide areas for utilitarian functions and delivery services separate from the realm of pedestrians and general traffic.

Figure 4.4.1(3): Commercial Alley

(5) Alley and Street Intersections

The intersection between an alley and a street should be treated as a driveway intersection. The sidewalk will not change elevation as it crosses the alley throat, but rather the alley will rise up to the sidewalk level and then ramp down to the street level. The sidewalk details of width and elevation must be maintained through the alley pavement. An illustration of this design is shown in **Figure 4.4.1(4)**.

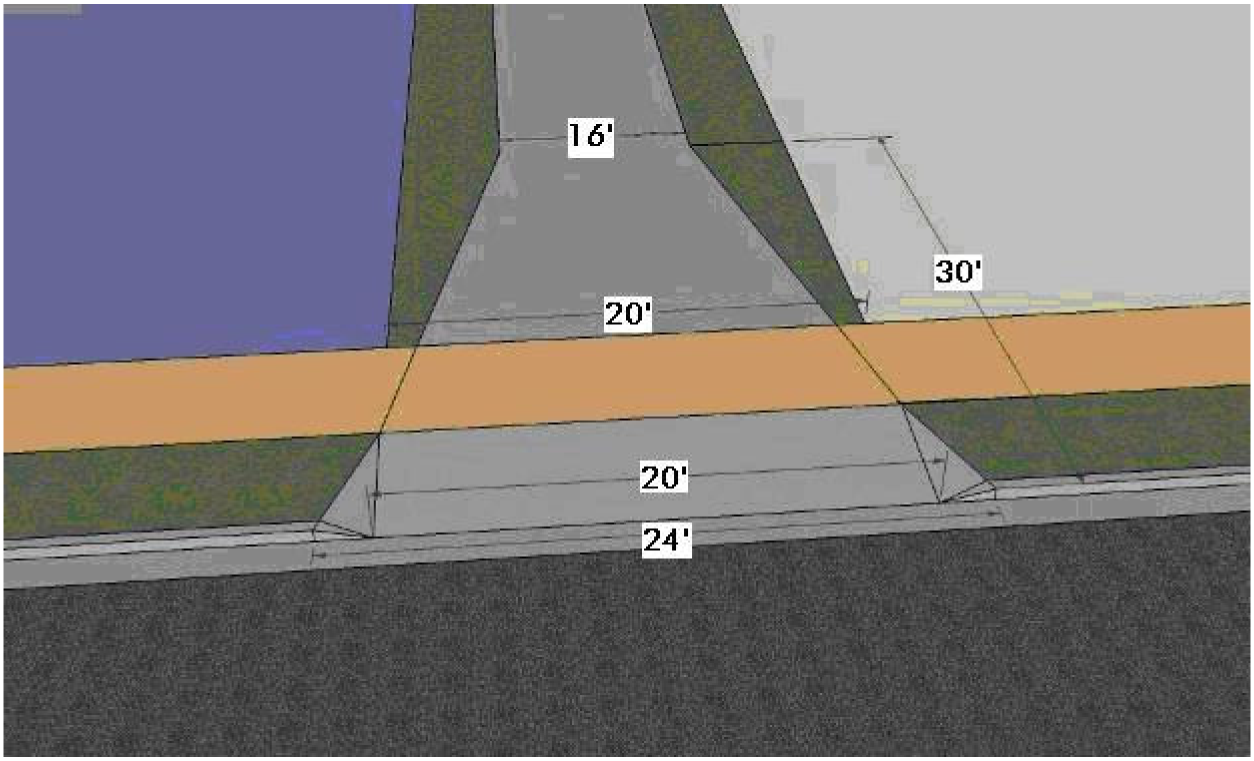


Figure 4.4.1(4): Alley Street Intersection

(6) Driveway Design Criteria

TND developers shall provide for compliance with the following standards for access from one or more TND lots to a public street:

Residential and mixed use neighborhoods: Access to streets shall be provided to lots primarily through the use of alleys. The use of front loaded driveways creates conflicts for pedestrians and bicyclists and interrupts the planting of street trees.

4.4.2 Cul-de-Sac Designs

Cul-de-sac designs should rarely be used in TND since they do not contribute to connectivity of the street network. When they are used, they shall comply with the standards included in **Chapter 3 Street Design,** and **Section 5.10.8** of the **Zoning Ordinance**.

4.4.3 Conceptual Yield Street Layout

Yield streets are typically used in residential areas where very low traffic speeds are desirable. The narrow pavement width requires passing cars to slow down and exercise caution. Cars parked on the street require passing drivers to stop and negotiate passage around the parked car. A typical cross section for a yield street is shown in **Figure 4.4.3(1)**.

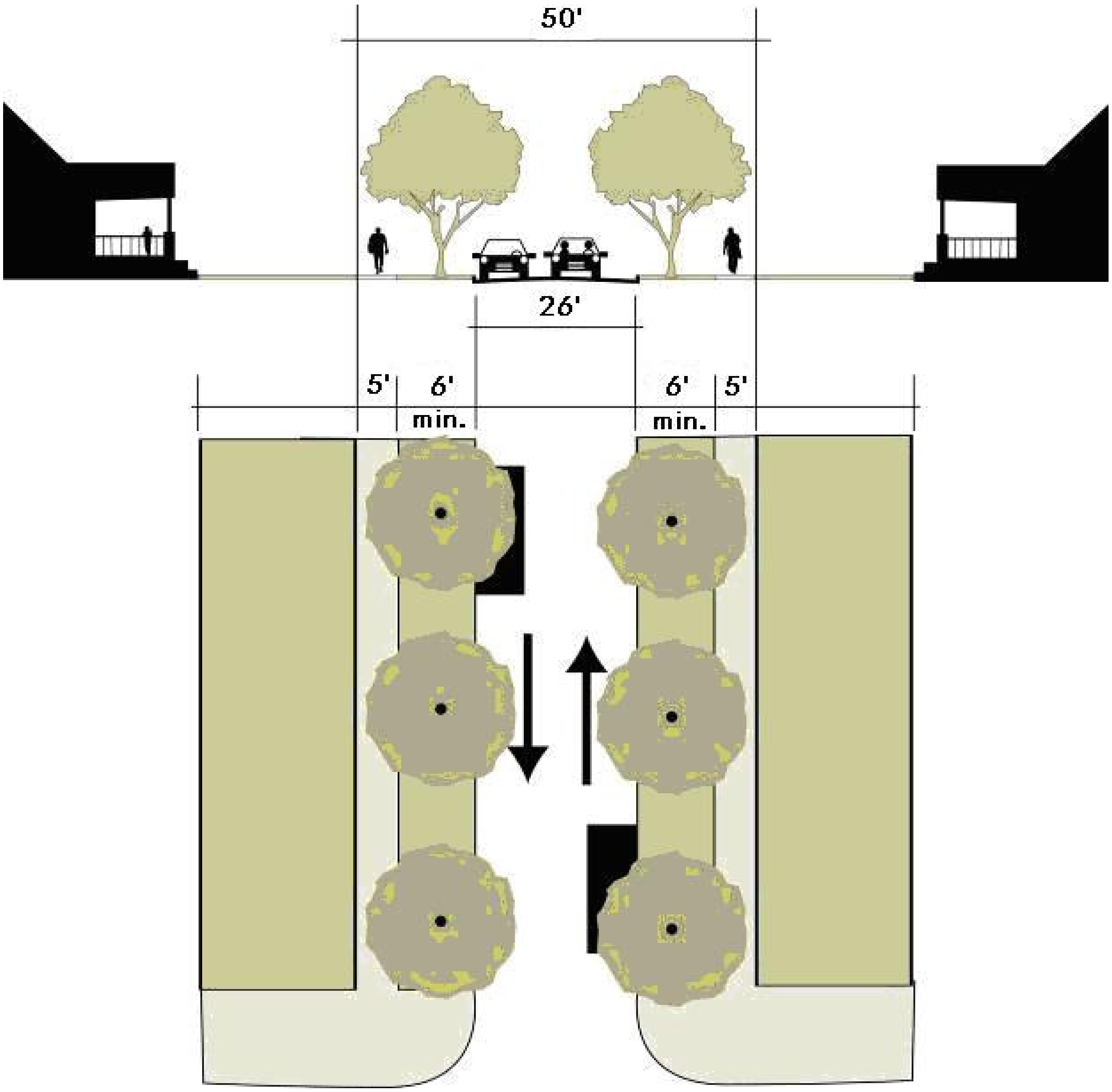


Figure 4.4.3(1): Conceptual Yield Street Section

4.4.4 Conceptual Street Layout

The Street is the standard street type in a T3/T4 area. The Street has development on both sides, as compared to a Drive type, and has on-street parking on one or both sides. A typical Street is shown in **Figure 4.4.4(1)**.

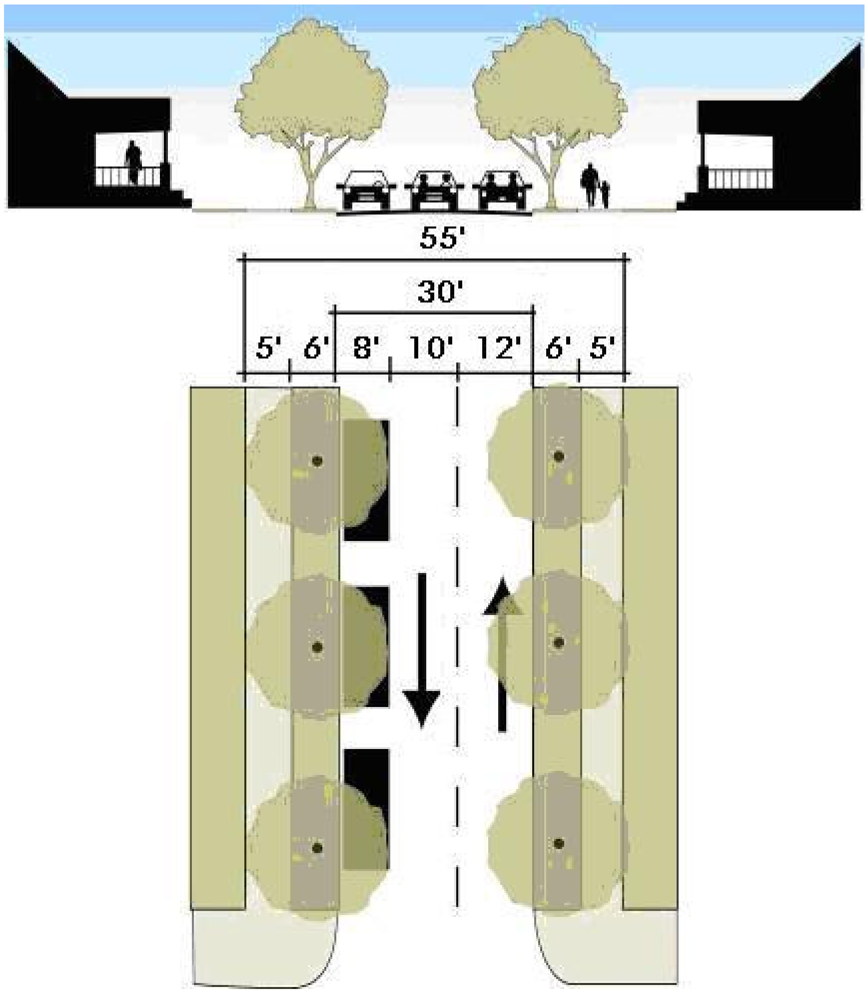


Figure 4.4.4(1): Conceptual Street Section

4.4.5 Conceptual Drive Layout

The Drive street type is used to place development adjacent to a park, water body, or other natural feature. The Drive has development along one side of the street only. The Drive will often have on-street parking only on the developed side of the street, but may have parking on both sides if the natural feature will require on-street parking (a city park or a ball field, for instance, would require additional parking.) A typical Drive design is shown in **Figure 4.4.5(1)**.

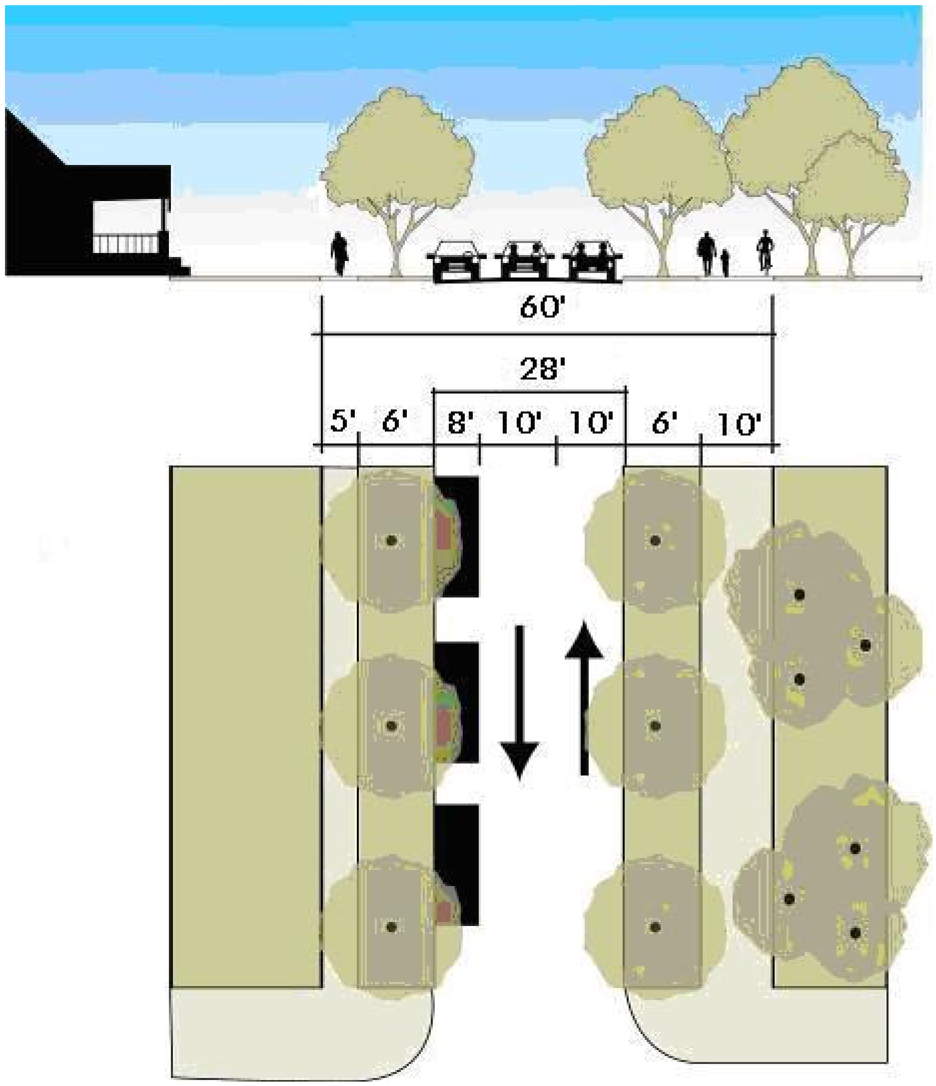


Figure 4.4.5(1): Conceptual Drive Section

4.4.6 Conceptual Town Street Layout

The Town Street is distinguished from a Street by the wider lane width and requirement for parking on both sides. The Town Street is designed for T-4 and T-5 areas where greater intensity and a greater percentage of large vehicles is expected. T-4 and T-5 areas can support public transit, for instance, and so need larger street geometry to more easily accommodate transit buses. At the same time, traffic speeds must be managed on these streets, requiring on-street parking, street enclosure, short block lengths, and higher levels of traffic congestion associated with more intensive land uses. The Town street type should be generally associated with the more intensive, more urban portions of the traditional area. A conceptual Town Street design is shown in **Figure 4.4.6(1)**.

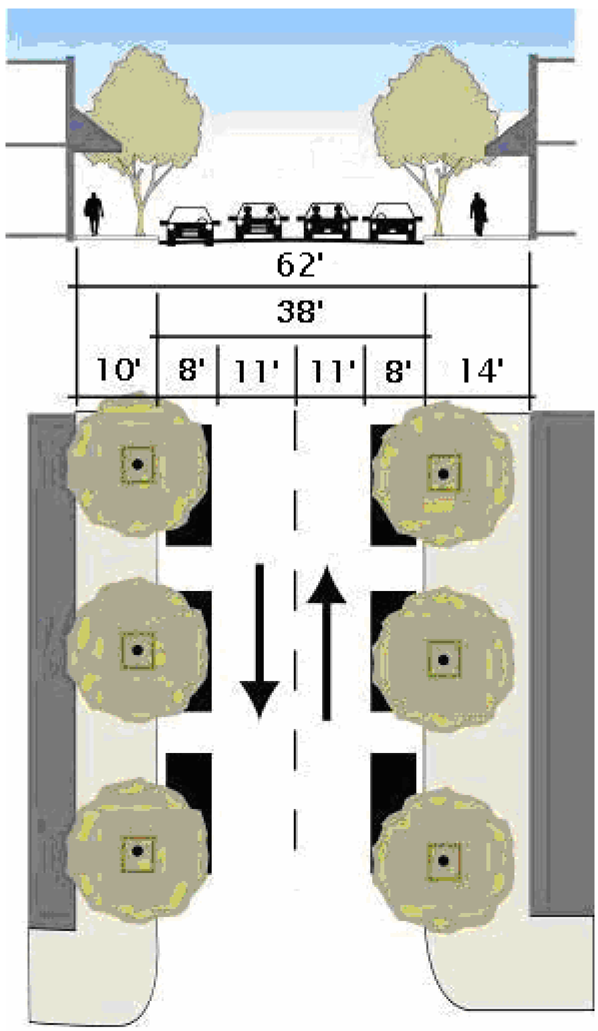


Figure 4.4.6(1): Conceptual Town Street Section

4.4.7 Conceptual Main Street Layout

The Main Street type is designed for the most intensively-used portions of the traditional area, in the T-5 and T-6 transects. These are areas with a diverse mix of uses including heavy commercial and retail uses, requiring extensive levels of parking access and turnover, as well as frequent usage by larger trucks and vehicles. This street type has the widest minimum sidewalk width (10') to encourage and accommodate high levels of pedestrian traffic. Parking is on both sides of the street and can be parallel or angled at 45 degrees. A conceptual Main Street design with angle parking is shown in **Figure 4.4.7(1)**.

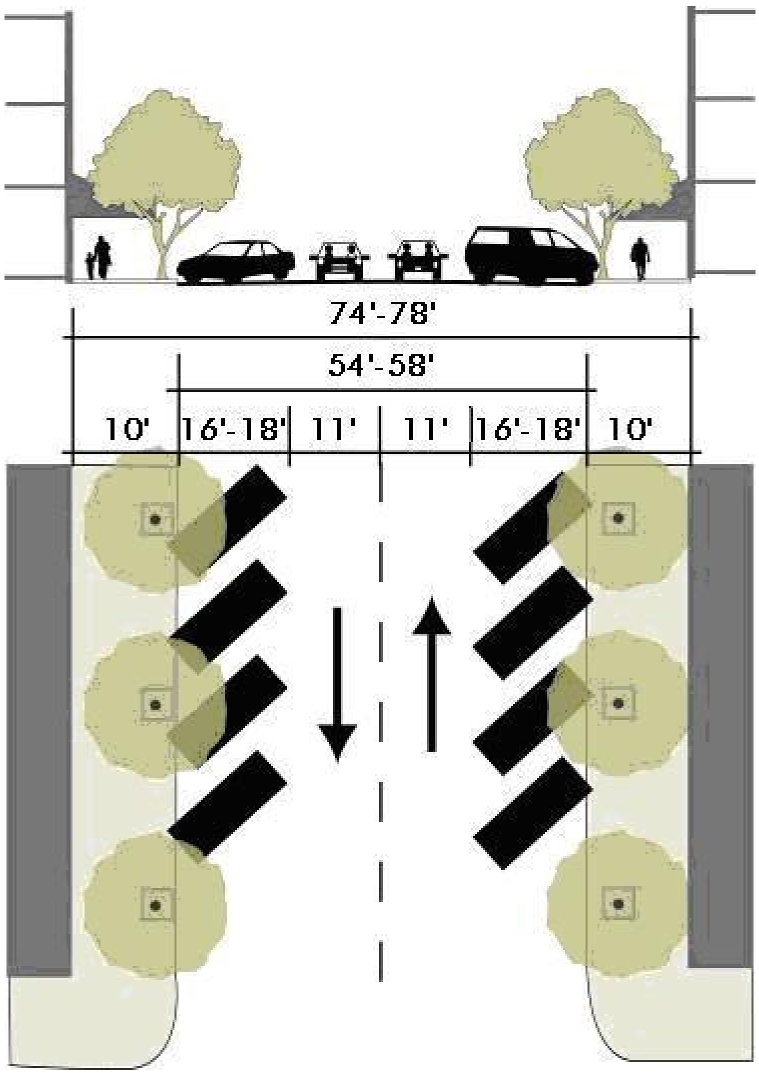


Figure 4.4.7(1): Conceptual Main Street Design

4.4.8 Conceptual Avenue Layout

Much-loved by landscape architects and observers of great street design, the Avenue is a graceful street type found in many cities. It is typified by a central tree-lined wide median, with a travel lane and parking lane on either side. Avenues create a delightful experience for pedestrians and drivers through the sense of enclosure provided by the canopy of tree plantings. Avenues are typically used to provide a grand entrance or short connection between two important places. The wider travel lane width of 11'-12', necessitated by the median and parking lane, create higher vehicle speeds, so the Avenue must be used with care. A conceptual design for an Avenue is shown in **Figure 4.4.8(1)**.

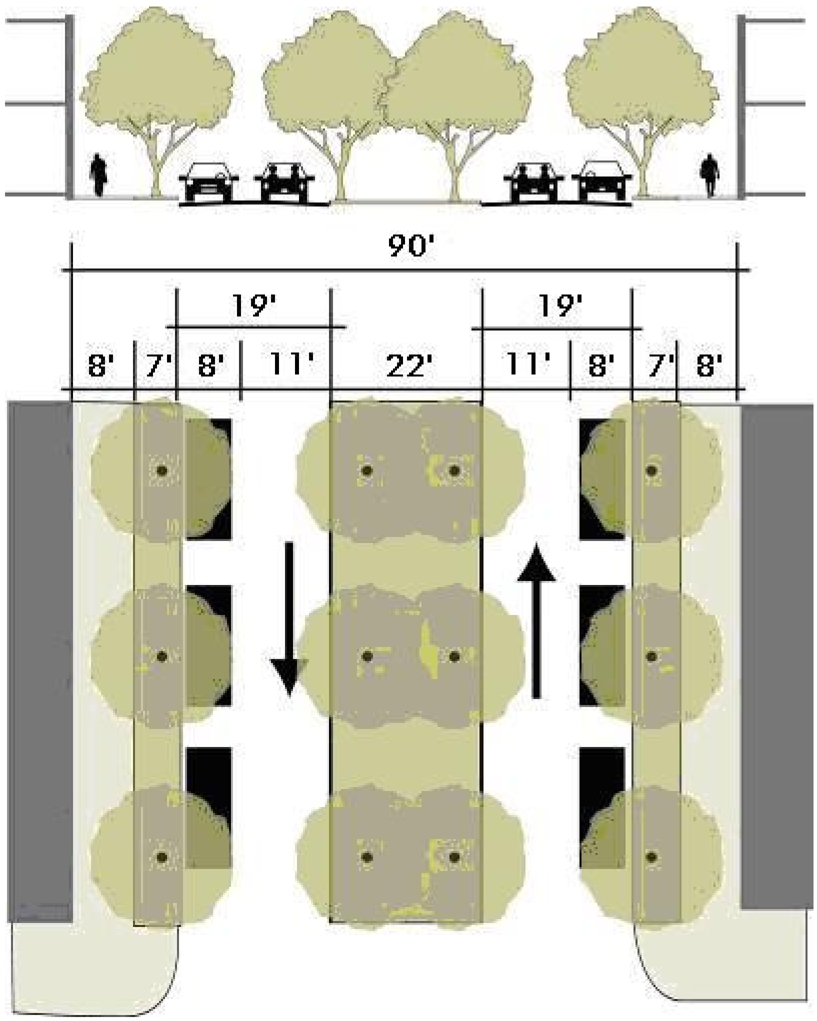


Figure 4.4.8(1): Conceptual Avenue Section

4.4.9 Conceptual Boulevard Layout

The Boulevard is designed to move traffic through a traditional area over longer distances. While maintaining the primacy of the pedestrian, the Boulevard also provides greater access and higher speeds for automobile traffic. Pedestrian travel is accommodated through wide medians with separate side access lanes and parking lanes, which also provide a location for street-front development. Through-traffic movements are separated from local traffic circulation and occur in the central portion of the Boulevard. This street type generally requires the greatest amount of ROW. A conceptual design for a typical Boulevard is shown in **Figure 4.4.9(1)**.

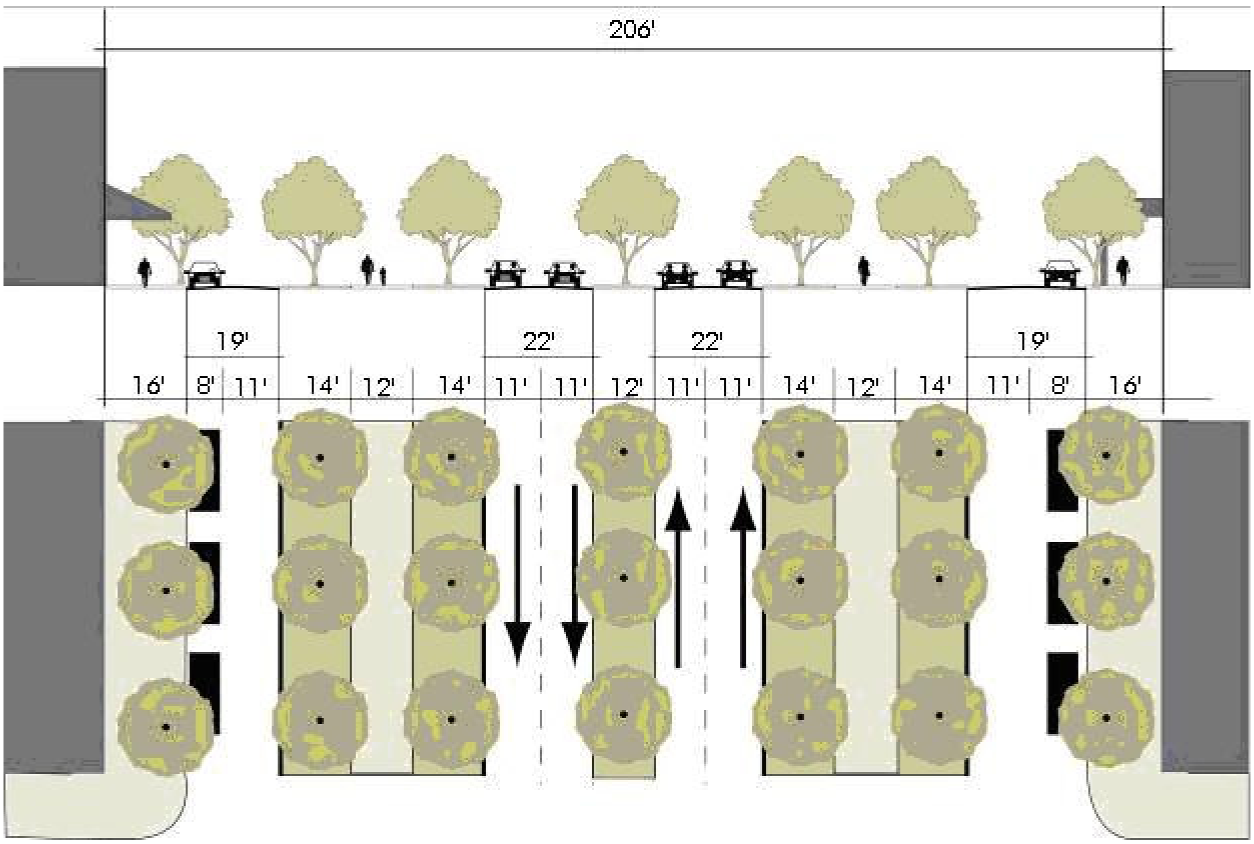


Figure 4.4.9(1): Conceptual Boulevard Section (Central Planted Median Not Needed in Areas with Blocks < 500')

4.5 Design Vehicles

Bicycles: Unlike conventional street design, TND streets need no special provisions or facilities to encourage or promote bicycle usage. The short blocks, mix of uses, and carefully managed traffic speeds will naturally generate bicycle traffic as an alternative to walking or driving. Conventional street design features such as bike lanes are not needed and are in fact counterproductive, as the wider pavement area provided by the bike lanes allows higher automobile operating speeds. The primary provision needed to promote bicycle usage is adequate bicycle parking.

SU-30 Truck: For T-1 through T-4 areas, the SU-30 standard utility truck is the appropriate design vehicle. This design vehicle provides a good approximation of the turning requirements for a garbage truck or utility truck, and in many cases a fire truck as well.

WB-50 Trailer Truck: For T-5-T-6 areas, where commercial and retail supplies may be delivered several times per week, provisions should be made for the WB-50 vehicle. These provisions may include flattening or reinforcing corners if necessary. An AutoTurn analysis is recommended to confirm appropriate turning geometry for these vehicles.

4.6 Striping

All streets within public rights-of-way shall use thermoplastic materials for striping. Generally the use of striping of lane lines for TND projects is discouraged except in cases where there are three or more lanes adjacent to one another or between designated bike lanes and the through lanes of the street.

4.7 Sidewalks

4.7.1 Location of Public Sidewalks

Sidewalks are required on both sides of all streets except alleys, and the undeveloped edge of neighborhood parkways, and shall comply with the standards in this section.

4.7.2 Placement

(a) In T1-T3 areas, sidewalks shall be set back a minimum of five feet behind the street curb. The intervening space between the back of the curb and the edge of the sidewalk is intended for the placement of street trees.
(b) In T4-T5 areas, sidewalks may be located at the back of the curb when on street parking is adjacent to the sidewalk. In no instance shall the intervening space between the back of the curb and the façade of a building be less than ten feet.

4.7.2 Minimum Width

Sidewalks running along lots, contiguous to buildings or abutting off-street parking lots shall meet the following minimum width standards:

(a) In no instance shall a sidewalk located within a public street right- of-way have a minimum width less than five feet.
(b) Sidewalks running in a perpendicular direction from off-street parking spaces shall have a minimum width of seven feet.
(c) Sidewalks abutting a nonresidential or mixed-use structure shall have a minimum width of eight feet.
(d) Sidewalks designed as multiuse paths shall have a minimum width of ten feet, preferably twelve feet

4.7.3 Material

Traditional neighborhoods shall have sidewalks within the ROW constructed of poured concrete with a brushed finish.

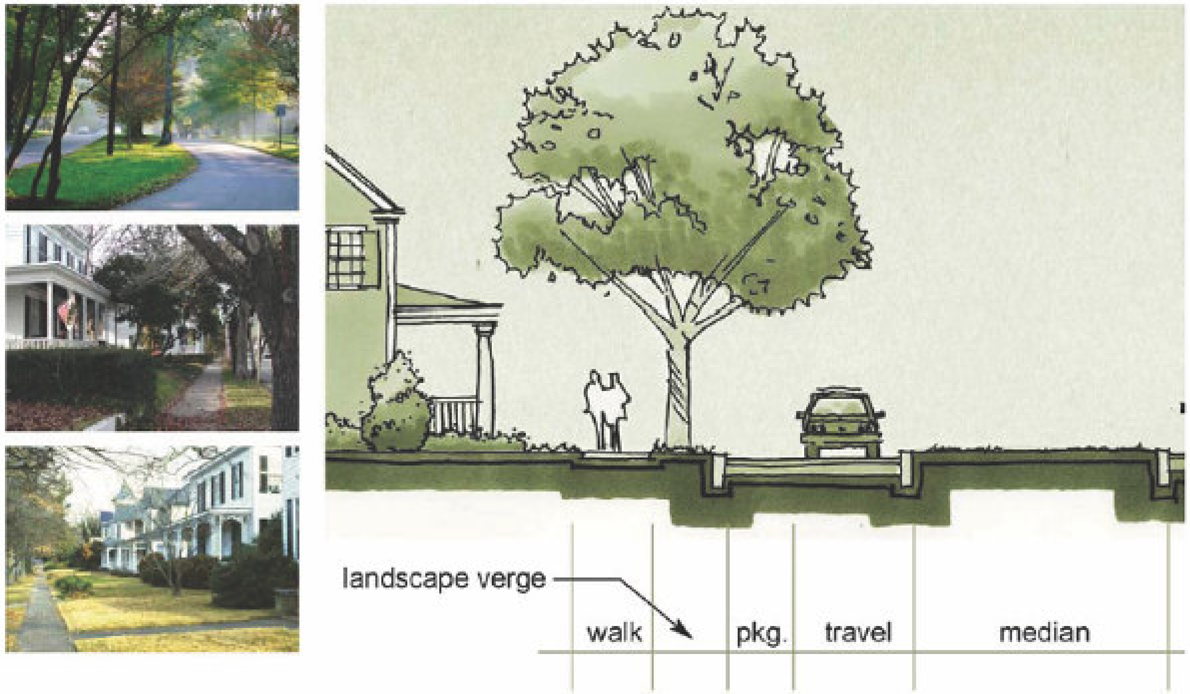


Figure 21: Typical Components of a Traditional Street

4.8 Street Trees

Street trees shall be required along both sides of all streets except alleys, and the undeveloped edges of neighborhood parkways in accordance with Chapter 5 of the Zoning Ordinance.

4.9 Streetscape Character in a TND

4.9.1 Streets

(a) TND streets have a narrow cross section and include elements such as parallel parking, landscape strips, and sidewalks. The travel lanes on two-way streets shall be no greater than 12 feet in width with parallel parking allowances of eight feet. Inset parallel parking is common on traditional streets.

(b) One-way streets may ring small parks or other public spaces. These narrow streets may have parallel parking on one side and shall have a total cross section of 14 to 20 feet.

4.9.2 Curbs

Curbs, when used, shall be six inches tall and shall be made concrete. Old concrete curbs may incorporate a steel angle to protect the curb edge from deterioration. Ribbon curbs are allowed in alleys.

4.10 Sight Distance

4.10.1 Visibility at Intersections

Circulation plans prepared for new development shall comply with the following minimum visibility standards:

(a) No fence, landscape, object, structure, vegetation, or wall shall be erected, maintained, or planted except for those meeting the requirements set forth below, within the sight triangle at an elevation greater than two and one-half feet above the crown of pavement on the adjacent roadway. A sight triangle shall be defined by the requirements below:

4.10.2 Clear Sight Triangles

Clear sight triangles are needed wherever streets intersect without a stop control. (Roundabouts and similar intersections having their own sight distance requirements are not included in this discussion.) The clear sight triangle provides street users (including automobiles, cyclists, and pedestrians) with adequate views of approaching traffic to determine when a safe crossing can be accomplished. Intersections with full stop control (such as stop signs or signals) do not require clear sight triangles for this reason, although a minimal level of intersection visibility is still desirable for general traffic operations.

The parameters for clear sight triangles are determined partly by physics, geometry and partly by observation of driver behavior. The amount of time required for approaching vehicles to stop from a design speed determines the "stopping distance" element of a sight triangle and is determined by the physics of braking and deceleration. The amount of time that drivers need to feel safe in attempting a turn or street crossing has been determined by observation, as has the distance from the through travel lane at which drivers typically stop to look for approaching traffic.

The clear sight triangles for a TND are based on the AASHTO Guidelines for Geometric Design of Very Low Volume Streets guide, modified to account for the low traffic speeds and urban design of a TND. The sight triangles are to be used on the minor (stopping) street to ensure that clear sight is available along the major (through or non-stopping) street. The speed of the through street determines the appropriate triangle. **Figure 4.10.2(1)** is the clear sight triangle diagram, which includes triangles for 15 mph, 20 mph, and 25 mph streets.

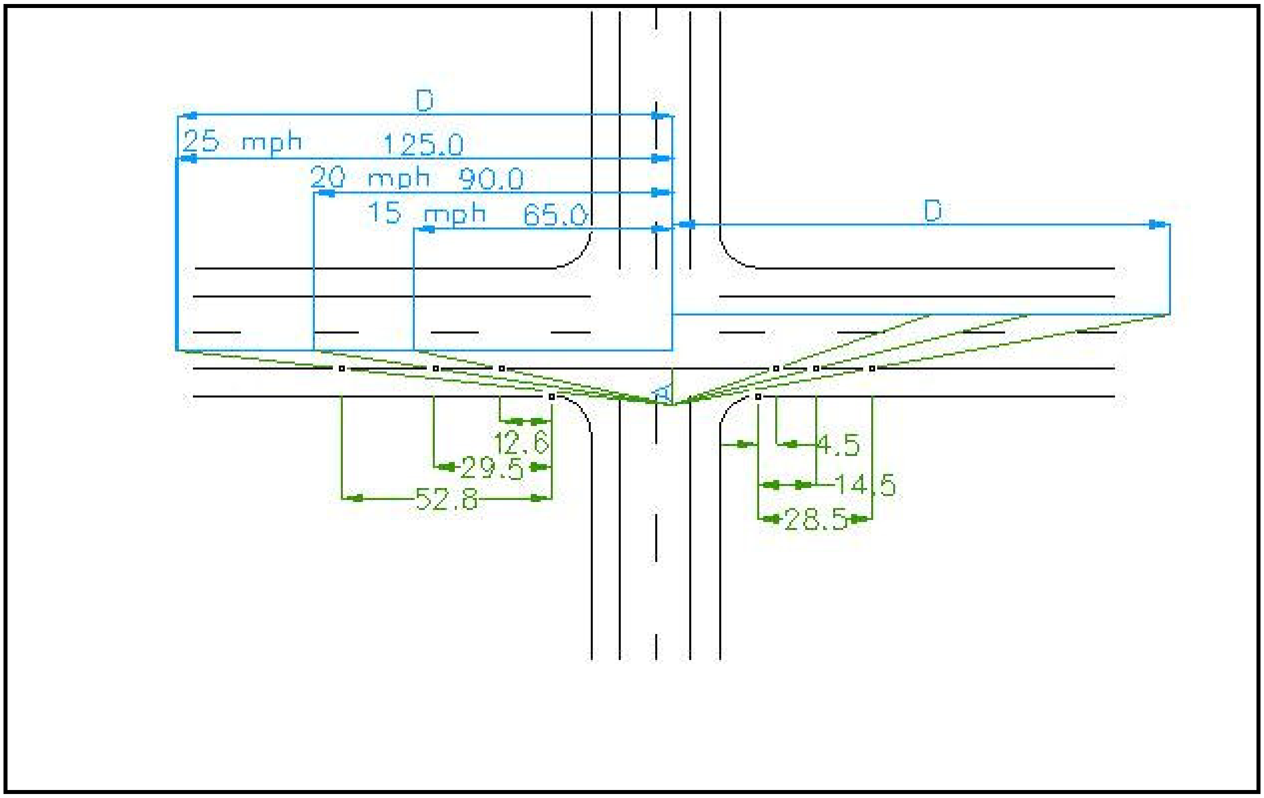


Figure 4.10.2(1): Clear Sight Triangle

In **Figure 4.10.2(1),** distance A is the distance from the through travel lane to the location of the driver of the stopped vehicle. This distance is measured along the lane centerline and is measured from the edge of the through travel lane. This distance is set as 9’, as determined through observation of driver behavior at a stop sign.

Distance B in **Figure 4.10.2(1)** is the stopping distance of an approaching vehicle. This distance is shown for 3 different design speeds – 15, 20, and 25 mph – as 65, 90, and 125, respectively. This distance is measured along the approaching lane centerline from the intersection of the approaching lane centerline with the stopped street approaching lane centerline. Distance B is shown in blue on the top portion of **Figure 4.10.2(1)**.

The clear sight triangle is constructed by adding a hypotenuse connecting the distal end of the Distance A vertex to the distal end of the Distance B vertex. The area enclosed within the clear sight triangle must be free of any obstructions higher than 3.5’ (the height of the driver’s eye per AASHTO).

In a TND, with low design speeds and sidewalks, the area encompassed by the clear sight triangle will be quite small and will generally only include the sidewalk, a planting strip, and the street itself. These areas are typically free of any structures already (such as walls or buildings). Possible sight obstructions such as street trees, lampposts, or street furniture must be carefully placed to ensure that the clear sight triangle is maintained. In the example provided in **Figure 4.10.2(1)**, of the intersection of two streets with on-street parking, the clear sight triangles are entirely within the street. For streets without on street parking, the sight triangles would include more of the sidewalk and area directly adjacent to the street.

Given the general lack of obstructions along a sidewalk and location of the clear sight triangle within the street, parked cars are likely to be the primary obstruction in the clear sight triangle. Figure 22 indicates the distance from the curb return in which parking must be limited for each approaching design speed. The distances are shown in green below the street, for both approaches to the intersection. General urban design already tends to limit parking within two car lengths (40-50 feet) of an intersection, and this practice will work well to preserve the clear sight triangle. In addition, many cars are not in fact obstructions, as approaching vehicles can be seen through and between the parked cars. Since larger SUV's and vans, however, are more difficult to see through, parking spaces should be limited at a minimum to within 30' of the intersection.

4.11 Curb Extensions

Curb extensions are a traffic-calming device that should not be needed in properly designed TND street networks. In fact, with appropriately narrow streets, curb extensions will interfere with the turning movements of emergency services vehicles. Therefore, curb extensions are considered conventional street design elements and are not appropriate for TND street design.

Chapter 5

EARTHWORK

5.1 Overview

This Section includes all clearing and grubbing, stripping topsoil, excavation, embankment, trench excavation, backfilling and testing required for construction of city streets within the City. Earthwork embankments and excavations shall be constructed in close conformance with the lines, grades and typical cross sections shown on the approved plans. Demolition of structures and other obstructions and abandonment plans are contained in Chapter 13 of these specifications. For all earthwork operations, the developer/contractor will be required to provide testing from an independent geotechnical firm pre-approved by the City. See Chapter 1 for additional testing and inspection requirements.

5.2 Reference Specifications

Unless modified by these specifications, all earthwork materials and construction requirements shall conform to the "Standard Specifications for Road and Bridge Construction" published by the Tennessee Department of Transportation (TDOT) (latest edition), hereafter referred to as the "Standard Specifications".

5.3 Permits

5.3.1 Grading Plans: Site plans are required for any projects disturbing more than 5,000 square feet of land use or for any site grading requiring stockpiling of material. Site plans showing limits of grading and proposed erosion control measures must be submitted to the City Engineer for approval prior to applying for a grading permit.

5.3.2 Permit Process: Once the grading and drainage plans are approved, the developer/contractor must complete the required steps prior to receiving a grading permit. See Chapter 1 for more information regarding permitting steps.

5.3.3 Street Excavation Permits: Separate street excavation permits for street cutting and road subsurface boring/jacking operations are issued at a cost of $100.00 each and expire after six months from the date of issue. A $10,000.00 bond is required for utility cuts or directional bores located within City right-of-way.

5.4 Soil Erosion/Sediment Control

All projects requiring a grading permit will require the development of a site specific erosion and sediment control plan. As a minimum, the plan shall provide for the temporary sediment control measures, designed to control runoff from a 2 year, 24 hour storm.

5.4.1 Stormwater Permits: All project erosion prevention and sediment control measures shall comply with the City's Stormwater Management Ordinance and the Best Management Practice Manual. The Stormwater Coordinator will determine if a specific Stormwater Permit is required. All erosion prevention and sediment control measures shown on the approved plans shall be in place prior to receiving a final approved grading permit.

5.4.2 Other Permits: The Contractor/Developer is responsible for obtaining all permits required by other agencies and/or government entities having jurisdiction including but not limited to Tennessee Department of Environment and

Conservation (TDEC), US Army Corp of Engineers and the Tennessee Valley Authority.

5.5 Utility Coordination

Locating and coordination for the relocation of existing utilities within the City's right-of-way is the responsibility of the contractor. Tennessee's One-Call utility location service shall be utilized in addition to coordination with local utility owners. The contractor shall at all times protect existing utilities and will be responsible for costs due to damage caused to any utility lines.

5.6 Clearing and Grubbing

Clearing the right-of-way of all vegetation and debris shall be limited to an area bounded by a line established five (5) feet beyond the actual line of construction unless otherwise directed by the engineer. Complete removal of shrub and tree roots is required except for sound undisturbed stumps and roots that will be a minimum of 5 feet below proposed subgrade or slopes which may be allowed to remain.

5.6.1 Tree Protection: Living trees with drip lines located beyond the construction lines are to remain undisturbed and protected by the contractor. The Developer will be responsible for establishing the lines of construction clearing in accordance with the above requirements.

5.6.2 Burning Permit: Burning of cleared vegetation and perishable debris is not allowed unless approved by the City Fire Department by issuance from the Fire Marshall of the required burn permit.

5.6.3 Debris Removal: Unless otherwise approved, all debris (i.e. cleared trees, brush, fences, building materials, etc.) shall be removed from the right-of-way, out of view from the street, and shall not be buried or otherwise become part of the street subsurface. Removal of cleared materials from the developer's property shall be legally disposed of.

5.7 Excavation

Excavation within the right-of-way includes stripping topsoil, grading of the street and required ditches, borrow material, channel excavation, rock excavation and undercutting. Excavation shall be performed in close conformance to the lines, grades, side slopes and typical cross sections of the approved construction plans.

5.7.1 Property Protection: Excavation shall be performed in a safe and orderly manner with due consideration given to protection of adjoining property and trees outside the clear lines. Approved erosion control measures shall be installed and regularly maintained to insure protection of adjacent properties. Excavated material when required shall be stockpiled in such a manner as to not obstruct streets, driveways or sidewalks.

5.7.2 Safety: All excavation shall comply with OSHA's "Construction Industry Standards" as well as all applicable Federal and state regulations. Protect open excavations and cut slopes with suitable means to protect workers, inspectors and other pedestrians able to access the site.

5.7.3 Structure Excavation: Excavation for bridges and pipes shall be in accordance with the Standard Specifications. Excess rock excavation below foundation elevations shall be filled with leveling concrete. Excess rock excavation below the elevation of the bottom of the pipe bedding, cradle or encasement shall be filled with material of the same type and placed and compacted in the same manner as the bedding material.

5.7.4 Channel Excavation: Excavation within waterways will require approved permits prior to commencing operations, and the equipment shall be kept out of the waterway to the greatest extent possible.

5.7.5 Blasting: Rock excavation requiring blasting shall be performed only after obtaining blasting permits from the City of Franklin Fire Marshall. Blasting operations shall be performed only by experienced, licensed blasting contractors. Blast areas shall be protected with mats or earth overburden to prevent flying debris. When blasting near public areas or motorists, blast zones are to be set up with proper signing and flagmen to secure the blast area prior to detonating explosives. The contractor shall be responsible for all damages and shall repair or replace any and all damages at no expense to the City. A pre-blast survey will be required by the Engineering Department.

5.8 Undercutting

When unsuitable material such as tree roots, trash, concrete and asphalt fragments or soft organic or plastic clays are encountered in the subgrade, the area shall be undercut and backfilled with select material.

5.8.1 Limits of Undercutting: Areas and depths of undercutting required for existing streets will be determined by City officials during inspections of subgrade construction and for final acceptance of city streets. The extent of undercut areas shall be determined by proof-rolling the subgrade and marking the areas of distress with marking paint or other means. Undercutting required after curbs are installed shall be located no closer than 12 inches from the nearest concrete face.

5.8.2 Proof-Rolling: Vehicles for proof-rolling shall be tandem axle dump trucks fully loaded with a minimum material payload of 23 tons. Material may be dry soil or rock loaded at the site or preferably loaded off-site at a quarry with crushed stone and accompanied with a certified weight ticket.

5.8.3 Backfill: Suitable material may consist of consistent soil from the site which matches the soil classification of the subgrade, or classified rock (surge rock) may be used. Backfill material should be placed in lifts not to exceed 12 to 24 inches and each lift shall be compacted with a dozer or other approved heavy equipment.

5.8.4 Stabilizing: Geotextile fabrics may also be used to strengthen backfill material in undercut areas provided the contractor can demonstrate their effectiveness on test repair areas at the same site or based on the recommendations of a pre-approved geotechnical engineer.

5.9 Embankment

Embankment material shall consist of approved soil or rock obtained from on-site excavations or hauled from a borrow pit area, and shall be placed in fill embankments in reasonably close conformance with the lines, grades, side slopes and typical cross sections shown on the approved plans. All embankments shall be placed in accordance with Section 205 of the Standard Specifications.

5.9.1 Soil Materials: All borrow material used shall be of AASHTO M145 classification A-6 or better or of the same classification or better than the predominant soil comprising the roadway excavation. Borrow material shall be free of organic material, and shall not be obtained from wetland areas.

5.9.2 Rock Materials: Embankments comprised of shot rock shall be processed from an acceptable screening and or selection process that produces rock of the required gradation. Rock shall meet soundness requirements for degradable or non-degradable rock under a 60,000 lb roller compactor as stated in the Standard Specifications.

5.9.3 Soil Placement: Embankments comprised of predominantly soil or degradable rock shall be placed in horizontal layers not to exceed ten (10) inches in depth before compaction and each layer shall be compacted to a density not less than 95% of the maximum density determined by laboratory testing. The top six (6) inches of the subgrade in both cut and fill sections shall be compacted to 100% of maximum density. Maximum density and optimum moisture content shall be determined by an independent testing firm using the Modified Proctor testing procedure. In-place embankment material that pumps under wheel loading of a fully loaded tandem axle dump truck during proof-roll testing shall be undercut and removed, regardless of density testing results. See Undercutting article for additional information.

5.9.4 Rock Placement: Embankments of predominantly non-degradable rock may be placed in three (3) feet thick lifts with no rock more than two (2) feet in thickness. Occasional rocks up to four (4) feet in thickness may be placed in the outer edges of the fill slope.

5.10 Trench Excavation

Trenches cut within the limits of the subgrade shall be excavated to
Neat lines to minimize disturbance of the surrounding material. The contractor/ developer is solely responsible for the stability of trench excavations and conformance with OSHA regulations.

All excavation for pipe and utility installation shall be performed in accordance with the Section 204 of the Standard Specifications.

5.10.1 Existing Street Cuts: Utility trenches cut into existing streets shall be performed in such a manner as to maintain the existing integrity and rideability of the street. Trench limits shall be saw-cut a minimum of 1 inch deep into the existing pavement. Excavation width shall be limited to the minimum width required to permit satisfactory jointing of the pipe and thorough backfilling.

5.10.2 Backfill: Utility trenches excavated into existing streets shall be backfilled with granular stone and placed in layers not to exceed 6 inches. Each layer of backfill material should be placed with optimum moisture content and thoroughly compacted with mechanical tampers.

5.10.3 Flowable Fill Backfill: For trench excavations subject to moderate and heavy truck traffic, the excavation shall be backfilled with flowable concrete fill. Pipe bedding shall be installed and thoroughly compacted prior to placement of flowable fill material. Concrete for flowable fill shall meet the requirements of Chapter 7.

5.10.4 Pavement replacement: Base stone and asphalt paving shall be placed over trench backfill with thicknesses and gradations equal to the existing street pavement section. As a minimum, the asphalt pavement section shall consist of 8 inch base stone thickness, 3 inch asphalt binder coarse thickness and 1.5 inch thickness of asphalt surface course. Each course of base stone and asphalt shall be thorough compacted with mechanical tampers. Limits of pavement replacement shall be the same as those stipulated in **Section 5.8, Undercutting**.

5.11 Underdrains

In addition to stormwater drainage structures and appurtenances, subgrade underdrains are required under city streets adjacent to medians with irrigation systems. Underdrains shall consist of free draining crushed stone, 4-inch diameter perforated pipe and filter cloth. All underdrains shall be constructed in accordance with TDOT standard drawing RD-UD-3 for underdrains with pipe and filter cloth.

5.12 Street Damages

Damage to existing streets and structures, utilities, trees, or private property shall be repaired and restored to its original condition by the Contractor. A minimum $1000.00 fine will be imposed for damage of existing streets due to hauling or otherwise moving equipment, spills of concrete, paint, oil or any other debris which damages the street or results in cleanup costs for the City.

5.13 Dust Control

The contractor/developer shall sprinkle the street construction surfaces with water or apply a dust-allaying material when such operations are necessary to prevent a dust nuisance or if directed by the City Engineer.

5.14 Final Dressing

Street side slopes and ditches shall be shaped within reasonably close conformity to the specified lines, grades and cross sections. Ditches shall be fine graded to eliminate areas of ponded water. All rock cuts shall be scaled of all loose fragments and left in a neat, safe and workmanlike manner.

5.15 Seeding and Sodding

All slopes, ditches and detention ponds shall be stabilized with seeded
grass or preferably sod. Stabilizing of disturbed areas shall be accomplished when the section of residential development is 80 percent complete or when the construction of local streets is substantially complete. Stabilized areas shall be considered acceptable for final inspection when the seeded or sodded area has an 80 percent or better establishment of grass coverage.

CHAPTER
6

PAVEMENT DESIGN

6.1 – Overview

The Contractor (Developer) shall provide all plant, labor, material and equipment to furnish and construct the bituminous concrete pavements in reasonable close conformity with the lines, grades, thickness and typical cross sections shown on the construction standards and specified herein, or as called for on the approved plans and specifications.

The specifications referenced for each material shall fully apply and no deviations from said specification limits or quality will be permitted unless specifically stated otherwise in this Section. The failure of any component of a product to comply with the referenced specifications shall constitute failure of the whole product.

The Contractor (Developer) shall obtain approval of the subgrade and stone base from the Street Department Director prior to commencing with the paving operations.

For all paving operations, the developer/contractor will be required to provide testing from an independent geotechnical firm pre-approved by the City. See **Chapter 1** for additional testing and inspection requirements

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6.2 – Requirements

6.2.1 – General Criteria

(a) - Existing Streets

For existing streets the City Engineer may require testing of the existing pavement and base structure to determine if an overlay is feasible, or if reconstruction is necessary. The City Engineer shall notify the Developer if and when this testing is required prior to the Final Pavement Design Report.

(b) - TDOT Design Standards

The design criteria and procedures presented follow the TDOT Standard Specifications for Road and Bridge Construction, Sections 307, 407, 411, & 907, dated March 1, 2006 and the American Association of State Highway and Transportation Officials (AASHTO) 1993 Guide for the Design of Pavement Structures.

(c) - Pavement Type

Streets are to be constructed of asphaltic concrete pavement, base course material, or subbase material (where required), placed on compacted subgrade.

(d) - Treated Subgrade

The use of treated subgrade, treated base, and/or full depth asphalt pavement may be acceptable when designed and submitted by the designer, and approved by the City Engineer in accordance with these standards as well as as well the TDOT Standard Specifications for Road and Bridge Construction, Sections 302, 304, & 306.

(e) - Approval

A preliminary pavement design may be submitted with final construction plans. The City Engineer shall review and approve the Pavement Design Report prior to construction.

6.3 – Design Criteria

6.3.1 – Design Factors

(a) -ADT & Equivalent Daily Load Applications (EDLA)

Loading values can be calculated using TDOT approved ADT numbers or Equivalent Daily Load Applications (EDLA) and Equivalent Single Axle Loads (ESAL) units if available. The City of Franklin Major Thoroughfare Plan traffic data should be used as a reference.

(b) - Minimum Pavement Section

The standard drawings in the Appendix provide the default acceptable pavement sections for each street classification based on assumed subgrade support and traffic values. These pavement thicknesses may be used for preliminary planning purposes, cost estimates, or final pavement designs when approved by the City Engineer. All pavement thickness designs must be based on actual subgrade support test results (refer to the Earthwork Chapter) and traffic projections for the specific project. In specifying layer thickness, the designer shall consider how the pavement section will be physically constructed (e.g. Specify how to construct 2' of treated subgrade.)

(c) - Flexible Pavement Strength Coefficients

Nonstandard design coefficients may be used, only if approved in advance by the City Engineer. In addition, design values must be verified by pre-design mix test data and supported by daily construction tests.

6.3.2 – Special Considerations

(a) - Staged Construction

This is an alternative for the Developer to provide a minimum thickness pavement during construction, and after repairs, construct the final lift of asphalt, providing for a new finished pavement surface. Minimum asphalt and aggregate base course thicknesses are given in alternate composite sections using Grade SG hot bituminous pavement (HBP) may be submitted for approval with a minimum wearing course thickness of 2.0 inches. If the full pavement section is not to be placed immediately, a pavement design for staged construction may be required by the City Engineer. The staged construction design must include asphalt thickness for each proposed stage. Calculations, traffic numbers, and construction truck traffic numbers supporting the staged design must also be submitted. For staged construction, accommodations must be provided for the paved surface to drain with no water left standing on the pavement.

(b) - Full Depth Sections

Full depth asphalt pavement sections will be considered on a case by case basis where depth of bedrock, drainage, and soil conditions are compatible with full-depth asphalt.

(c) - Rehabilitating/Repairing Existing Streets

On paved surfaces, within public right-of-ways, do not use or operate tractors, bulldozers, off-road trucks or other power-operated equipment, the treads or wheels of which are so shaped as to cut or otherwise damage such surfaces. Damaged roadways shall be repaired to the City's satisfaction by the Contractor (Developer). Placing of mats or using other methods of protection may be allowed subject to the approval of the Street Department Director.

Any roadway surface damaged shall be promptly restored to a condition at least equal to that in which they were found immediately prior to the beginning of operations. Suitable materials and methods shall be used for such restoration. All dirt and mud tracked on existing roadways shall be removed promptly.

Prior to overlaying existing asphalt, the City Engineer may require nondestructive testing to determine the amount of overlay necessary to bring the street to current standards. The method of nondestructive testing and the data obtained must be in a form compatible with the pavement management system for the City Engineer. All "pot-holes," utility trench settlement, cracking, and any similar imperfections shall be repaired to the City Engineer's satisfaction prior to overlaying. The following should serve as a guideline for the rehabilitation and repairing of existing asphalt streets in the City:

(i) General - The contractor is to provide the necessary labor, materials and equipment to restore and maintain the various street and driveway surfaces of all types, pavement and driveway bases, curbs, curbs and gutters, and sidewalks disturbed, damaged, or demolished during the performance of the work.

(ii) Permits - Before starting any work, secure the necessary permits to work within the City or State ROW and easements when surface materials will be disturbed or demolished.

Separate street excavation permits for street cutting and road subsurface boring/jacking operations are issued at a cost of $100.00 each and expire after six months from the date of issue. A $10,000.00 bond is required for utility cuts or directional bores located within City ROW.

(iii) Materials

The quality of materials used in the restoration of existing streets, parking areas and driveways shall produce a finish surface equal to or better than the condition before work began. Compacted crushed stone backfill shall be in conformance with the TDOT Standard Specifications for Road and Bridge Construction.

Asphalt for a temporary patch shall be Bituminous Plant Mix Surface Course (Cold Mix) as specified in the TDOT Standard Specifications for Road and Bridge Construction.

(iv) Execution

Where trenches have been opened in any roadway or street that is a part of the State of Tennessee highway system, restore surfaces in accordance with the requirements of TDOT. All other restorations shall be done in accordance with the City Standards; these Specifications and the Standard Details.

Before trenching in paved areas the Contractor shall saw-cut the pavement in a straight line along the sides of the proposed trench to allow for pavement removal and trench excavation without damage to adjacent pavement. During construction, suitable precautions shall be taken to protect the pavement edges and surfaces and to minimize damage.

Upon completion of the utility installation, including backfill, fill the trench with crusher run and temporary pavement patch until such time that the permanent pavement patch will be constructed. The temporary patch shall be placed the same day or within 24 hours. The temporary pavement patch shall consist of at least six (6) inches of compacted stone base brought to within two (2) inches of the surface of the existing permanent pavement. A two (2) inch layer of cold mix asphaltic concrete shall then be applied to protect the base, prevent "pot holes" or "chuck holes", and provide a reasonably smooth pavement surface until the permanent patch is made. The temporary pavement patch shall be placed within twenty-four (24) hours of the completion of the utility installation. Permanent Hot Mix patching shall only be applied after the Cold Mix patch has been completely removed.

Concrete curbs, gutters and sidewalks shall be restored as required to match existing construction. Replace damaged sections with complete new sections or squares; patching of damaged sections will not be permitted.

When a manhole or valve box frame and cover, or other utility casting, requires adjustment to an elevation one inch or more above the existing pavement grade and is exposed to traffic before final paving is completed, a temporary ramp shall be constructed by feathering a cold mix for 360 degrees around the casting. A taper slope of not less than two feet per one inch shall be used. During the final paving operation the temporary ramp shall be removed from around the casting to allow for the permanent paving installation.

6.3.3 - Special Requirements

The City Engineer may require full depth asphalt or Portland cement concrete or chemically treated base or subgrade in locations where traffic, utilities, type of construction, subsurface drainage, or time of construction would make asphalt on aggregate base impractical.

6.4 – Pavement Structure Components

6.4.1 - Subbase

The layer(s) of specified or selected material of designed thickness placed on a subgrade to support a base course, surface course, or both.

A minimum of one boring shall be obtained for any roadway segment. A second boring shall be required in the trench of any installed utilities. The distance between borings shall not exceed 500 feet, two borings per location where utility trenches exist (one boring in the trench and one in compacted subgrade). Multiple samples shall be taken alternately among lanes and shall be evenly spaced. The City Engineer may require more frequent testing to insure that the subbase meets the adequacies presented in the design report.

6.4.2 - Base Course

The mineral aggregate base (stone base) shall be crushed stone as manufactured by local quarries in accordance with TDOT Standard Specifications

The composite gradation of aggregate for the mineral aggregate base and for surface courses shall be Class A, Grading D, Pug Mill Mix, as specified in the TDOT Standard Specifications for Road and Bridge Construction (TDOT).

6.4.3 - Surface Course

One or more layers of a pavement structure designed to accommodate the traffic load; the top layer of which resists skidding, traffic abrasion and the disintegrating effects of climate. For asphalt pavement the top layer is sometimes called "Wearing Course." Asphalt thicknesses for surface courses are typically 1 ¼" to 1 ½" thick. For asphalt overlay projects, the total thickness of asphalt should be no more than 4".

6.5 – Asphaltic Concrete Pavement Design

6.5.1 - Material

The asphaltic concrete surface shall be a bituminous concrete consisting of crushed stone with fine aggregate, and stone screenings, or combination thereof, combined with asphaltic cement and sand resulting in a mixture of Grading D.

For City funded projects, use Grading E surface course mix for all streets other those classified as arterial streets. Grading D surface course mix shall be used for all arterial streets.

Aggregate for the plant mix surface course shall be sized, graded and combined in such proportions that the resulting composite blend meets the following gradation requirements, together with the stipulations pertaining to the constituents of the blend hereinafter specified in the TDOT Standard Specifications for Road and Bridge Construction (TDOT).

When Grading E is used for surfacing of shoulders or other no traffic lane construction, the mineral aggregate may be composed entirely of limestone and manufactured sand, but in no case shall the mineral aggregate for this construction consist of less than 50 percent limestone.

6.5.2 - Procedure

All pavement design shall adhere to the specifications set forth in the TDOT Standard Specifications for Road and Bridge Construction (TDOT).

Pavement is required to be a 20 year design.

6.6 – Rigid Pavement Design

For concrete rigid pavement, see **Chapter 7, Concrete**, for concrete riding surfaces.

6.7 – Design Report

The pavement design report shall be prepared by an independent geotechnical laboratory under the supervision of and signed and stamped by a Professional Engineer registered in the State of Tennessee. The report shall make a recommendation for a typical pavement structural section based on known site soil conditions and the valid traffic impact study. The following list of items should be included in the report:

1) Vicinity map to locate the investigated area.
2) Scaled drawings showing the location of final borings.
3) Final Plat with street names.
4) Scaled drawings showing the estimated extent of subgrade soil types and EDLA for each street classification.
5) Pavement design alternatives for each street classification.
6) Tabular listing of sample designation, sample depth, Group Number, liquid limit, plasticity index, percent passing the No. 200 sieve, AASHTO Classification, Group Index and soil description.
7) R-value test results of each soil type used in the design.
8) Borrow source identification.
9) Pavement design computer printouts or nomographs properly drawn to show Soil Support - EDLA - SN
10) Design calculations for all phases of soil report.
11) Design coefficient used for asphalt, base course, etc.
12) A discussion of potential subgrade soil problems including, but not limited to:
    - Heave or settlement prone soils.
    - Frost susceptible soils.
    - Ground water.
    - Drainage considerations (surface and subsurface).
    - Soluble sulfates in subgrade.
    - Other factors or properties that could affect the design or performance of the pavement system.
13) Recommendations to alleviate or mitigate the impact of problems discussed in the previous paragraph.

6.8 – Installation

The mineral aggregate base shall be constructed in one or more layers with the compacted thickness being that as shown on the approved plans or the construction standards. Prior to the spreading of any mineral aggregate, the subgrade shall be proof rolled with a fully loaded tandem dump truck (or other approved equipment). Any areas which pump will require undercutting, backfill and compaction to specified limits. Additional proof rolling shall be required for all repaired areas.

Hauling over material already placed will not be permitted until it has been spread, shaped and compacted to the required density.

If the required compacted depth of the mineral aggregate base course exceeds six (6) inches, the base shall be constructed in two or more layers of approximate equal thickness. For total base thickness of 8", lifts shall be placed and compacted in 4" thicknesses. For 10" base thickness, lifts shall not exceed 5".

Except where mechanical aggregate spreading equipment is used to place the mineral aggregate base material, final shaping of each layer prior to compaction shall be accomplished by motor grader. In the event that mechanical spreading equipment fails to shape the base material properly, final shaping shall be done by motor grader or other approved means.

Immediately following spreading, the mineral aggregate base material shall be shaped to the required degree of uniformity and smoothness and compacted to the required density prior to any appreciable evaporation of surface moisture. Compaction of each layer shall be continuous until the minimum density requirement is achieved. Compacting equipment shall be smooth drum steel wheel vibratory rollers.

For density testing purposes, each completed layer is to be divided into lots of approximately 10,000 square yards. Five density tests are to be performed on each lot and the results averaged. Smaller lots may be considered when directed or approved by the City Engineer.

The average dry density of each lot shall be not less than 100 percent of theoretical density based upon 83 percent of a solid volume, unless otherwise specified. Further, no individual test shall be less than 97 percent of theoretical. The theoretical density of aggregates shall be based on bulk specific gravity AASHTO T-99. The theoretical density of all other aggregates shall be based on bulk specific gravity AASHTO T-85 AND T-99.

When mineral aggregate base is used to widen an existing pavement, to construct shoulders for resurfacing projects, base placed on bituminous asphalt mix, or base used for structure backfill, the average density of each lot shall be not less than 95 percent if maximum density determined in accordance with AASHTO T-99, Method D, unless otherwise specified. Further, no individual test shall be less than 92 percent of maximum density.

The thickness of the completed mineral aggregate base shall be in reasonably close conformity to the thickness shown on the approved plans or as called for by the construction standards. The thickness shall be measured at such frequency as established by the City Engineer, or the City Street Director by means of test holes or other approved methods.

The surface of the finished mineral aggregate base shall be in reasonably close conformity to the lines, grades and cross-sections as shown on the approved plans or construction standards and shall have a satisfactorily smooth riding quality.

Upon completion of the mineral aggregate base, it shall be maintained, under traffic if required, smooth and uniform until covered by the following stage of construction.

The mineral aggregate base, prepared as outlined herein, shall be sprinkled lightly with water to settle any loose dust. The bituminous prime coat shall then be applied uniformly over the surface of the base by the use of an approved bituminous distributor. The prime coat shall be applied at the rate of three-tenths (0.3) gallon per square yard and shall be maintained at an application temperature between 60 and 140 degrees Fahrenheit (F). Any areas containing an excess or deficiency of priming material shall be corrected by the addition of blotter material or bituminous material, as directed by the City Engineer or Street Director.

The Contractor shall protect all structures and concrete surfaces from the bituminous material curing construction. If after the bituminous prime coat has been applied, it fails to penetrate before traffic has to be turned back on the road, or paving is interrupted overnight, a dry cover material shall be spread at a rate of ten (10) pounds per square yard to prevent damage to the primed surface. An excess of cover material shall be avoided. The cover material shall be applied with suitable spreading devices to prevent the tires of the trucks from running over the fresh bituminous prime coat.

The Contractor shall maintain the prime coat and the surface intact until it has been covered by the following stage of construction. No succeeding stage of construction shall be placed upon the prime coat until it has properly cured.

The asphaltic concrete base course or surface course; bituminous plant mix (Hot Mix); may be placed on properly constructed and accepted subgrade or previously applied layers provided the following conditions are met:

1. The subgrade or the surface upon which the hot mix is to be placed shall be free of excessive moisture.

2. The Hot Mix shall be placed in accordance with the temperature limitations of the following table and only when weather conditions otherwise permit the pavement to be properly placed, compacted and finished.

6.9 – Testing

6.9.1 - Inspection and Acceptance

All pavement installations and repairs will require the contractor to submit material testing certifications to the City Engineer. Materials should meet the requirements found in the TDOT Standard Specifications for Road and Bridge Construction. The following should be considered for the submittal:

1) Liquid Asphalt: Certification is needed to show specification compliance including the performance grade of the material.

2) Aggregate: A completed mix design along with aggregate stockpile results with percent passing each sieve.

3) Completed Mix: Complete mix gradation should be documented by tests using one of the following methods: Hot Bins, Vacuum Extraction or Burnout Oven Testing.

4) Compaction: Density results shall be compliant with the TDOT Standard Specification Section 407 and field verified. The percent voids in the total mix and the theoretical gravity of the mix should be documented as a bare minimum.

The City Engineer reserves to right to request any additional tests deemed necessary for acceptance.

Chapter 7

CONCRETE

7.1 Overview

This Section includes cast-in-place and pre-cast concrete, including reinforcement where required, concrete materials, mix design, placement procedures, and finishes. All concrete pavements, sidewalks, ramps, driveway aprons, curb and gutter sections, paved ditches, pipe and pipe end treatments, box culverts and bridges, drainage structures, foundations and wall panels and all other miscellaneous concrete elements indicated on the approved drawings shall be constructed in accordance with these specifications unless approved otherwise by the City. All concrete shall be ready mixed concrete and not field mixed unless otherwise approved.

The Contractor (Developer) shall provide all materials, labor, and equipment necessary for the completion of all concrete work in accordance with the lines, grades, thickness and typical cross sections shown on the construction standards specified herein, or as indicated on the approved plans.

7.2 Reference Specifications

Unless modified by these specifications, all concrete materials and construction requirements shall conform to the “Standard Specifications for Road and Bridge Construction” published by the Tennessee Department of Transportation (TDOT) (latest edition), hereafter referred to as the “Standard Specifications”.

Where project plans and specifications refer to particular items, materials, equipment and construction requirements, the appropriate section of the Standard Specifications shall apply. Standard Specification sections regarding compensation shall not apply unless directed by the City Engineer. The absence of a description or specification for any item of work shall automatically refer to the appropriate section of the Standard Specifications.

TDOT Specification Section 604 shall apply for all structural concrete to be used in load carrying structures including box and slab culverts, foundations including drilled caissons, traffic signal and overhead sign foundations, retaining walls and girder bridge members. Section 604 also specifies the requirements of concrete used in structures as well as other miscellaneous or incidental items.

Miscellaneous concrete items such as sidewalks, curbing and gutters, rigid street pavement, medians, driveways, paved ditches and roadside sign foundations, shall meet the requirements of TDOT Specification Sections 700 through 703.

All precast concrete including precast drainage structures, headwalls, box culverts, pipe, temporary barriers, noise and retaining walls, and bridge members shall meet the requirements of TDOT’s Standard Operating Procedure 5-3 regarding the “Manufacture and Acceptance of Precast Concrete Drainage Structures, Noise wall panels, and Earth Retaining wall products”. This document requires that all producers of precast concrete products be certified in accordance with national quality standards developed by the National Precast Concrete Association (NPCA), the American Concrete Pipe Association (ACPA) and/or the Prestressed Concrete Institute (PCI). Certified producers must submit a copy of their certifications and documentation that have successfully completed the annual inspections. The City Engineer may waive the requirements of precast concrete producer certification on a case-by-case basis.

7.3 Submittals

Where required in the project plans, technical performance and/ or quality certification of concrete materials proposed for the work shall be submitted to the City Engineer for approval. Such submittals may include the following:

7.3.1 Concrete Mix Designs

Concrete mix designs are required for load carrying structures such as bridges, box culverts, large junction boxes within the roadway and retaining walls. Mix designs shall be prepared and certified by approved materials testing company, or alternately, an existing TDOT approved design may be submitted provided the design is approved within the calendar year. Mix designs shall certify all admixtures and cement replacement such as fly ash proposed for the project concrete.

7.3.2. Reinforcing Steel

Certifications for reinforcing steel used in load carrying structures shall be submitted to the City Engineer. Letter of certification shall bear the signature of the supplier’s representative and shall certify that the reinforcing meets the requirements of the Standard Specifications.

7.3.3 Miscellaneous Items

Items included in the concrete work such as handrails, anchors, joint materials, curing materials and other items may require submittals and or representative samples at the discretion of the City Engineer.

7.4 Concrete Classification

Use of the following classes of concrete per the TDOT Standard Specifications:

Application	Class	28 day Strength
Sidewalks & Bikeways	A	3500 psi
Curb and Gutters, Drainage Structures	A	3500 psi
Bridge substructures, Box Culverts, Retaining Walls	A	3000 psi
Light and Traffic Signal Pole Foundations	A	3000 psi
Bridge Deck Slabs	D or L	4000 psi
Underwater Foundation Seals	S	3000 psi
Leveling Concrete	A	3000 psi
Flowable Fill (backfill)	Excavatable EFF **	30 psi (140 psi @ 98 days)
Rigid Concrete Pavement	CP **	3000 psi

**(see Section 204 and Section 501 of the Standard Specifications)

7.5 Curbing and Sidewalks

7.5.1 Residential Sidewalks

All residential street sidewalks within the City shall be constructed within the street right-of-way and shall meet all City requirements and standard drawings. The sidewalk forms and base material shall be inspected prior to concrete construction.

It is the contractor's responsibility to ensure safety and maintain access for pedestrians when sidewalks are under construction and to protect the in place work from damage or vandalism.

Traffic control devices including cones, barrels and signs may be required on high volume streets to warn vehicular traffic in advance and adjacent to the area of construction.

1) All concrete sidewalks shall be a minimum uniform thickness of 4" using Class A Concrete, minimum 28-day compressive strength of 3500 psi. Sidewalks shall be constructed on 4 inches (minimum) of compacted, granular aggregate base stone (TDOT size #57 or #67). The base stone shall be hand compacted to a firm, even surface in reasonably close conformity with the grade and cross section required.

2) Subgrade soil which in the opinion of the City Engineer is soft or subject to large volume changes, shall be excavated and replaced with suitable material as approved by the City Engineer.

3) Where driveway and alley approaches cross the sidewalk, the minimum concrete thickness of the approach slab shall be 6”. See Standard Drawings for details. Granular base material for driveways shall be compacted base stone material conforming to Class A, Grading D of TDOT Section 303.02. A 2” lowered curb height above the gutter line shall also be maintained at the front edge of the driveway approach.

4) Reinforcement of residential sidewalks is required and shall consist of fiber mesh.

5) Sidewalk cross slope shall be a maximum of 2% sloping toward the curb. Longitudinal sidewalk grades may follow the running grade of the roadway; however a maximum grade of 5% is considered accessible.

6) For detached sidewalks, the difference in elevation between the top of sidewalk and the top of curb at any adjacent location shall not exceed the grade difference produced by a maximum 4:1 slope.

7) Sidewalk surface is to receive a light broom finish, to achieve a sandy texture with texture lines perpendicular to traffic. Exposed aggregate sidewalk finishes are not acceptable within the street right-of-way.

8) All exposed concrete edges shall be rounded to a 1/2” radius.

9) Final longitudinal surface variations shall not exceed 1/4” under a 12 ft straight edge and transverse variation shall not exceed 1/8” in 5 feet. Low spots which allow water to pond will not be acceptable.

10) Transverse control joints shall be spaced 5 feet maximum and shall be placed at right angles to traffic. Joints shall also be placed to intersect all inside or re-entrant corners. Joints shall be formed with a grooving trowel to a depth of 1 inch. The top edges of the grooves shall be rounded to 1/4” radius.

11) Longitudinal control joints are required for sidewalk widths greater than 6 feet and less than 10 feet. Two longitudinal joints are required for sidewalks greater than 10 feet. Longitudinal joints shall be centered in the width of the sidewalk.

12) Expansion joints shall be constructed with 1/2” thick pre-molded rubberized expansion joint filler (manufactured by J.D. Russell Company, or equal). Bituminous fiberboard shall not be used. Expansion joint material shall extend the full width of the sidewalk and the depth shall extend to within 1 inch of the top surface. Space expansion joints at 30 feet maximum spacing and at each driveway and at any cold joint. Expansion joints are also required at the back edge of driveway approaches between the approach and the private drive and at each side interface with the sidewalk.

13) 1” thick pre-molded expansion joints are required when sidewalks are adjacent to curved sections of the street curb and when curb is placed adjacent to buildings and/ or retaining walls. Use 1/2” isolation joints around other fixed objects like utility poles and hydrants. Use 1/2" expansion joints between the curb and sidewalks where constructed adjacent to each other.

14) Sidewalks and bikeways shall not be opened to pedestrian or bicycle traffic for at least 24 hours after placement. The contractor shall provide and maintain measures to restrict use during the curing period.

15) Concrete driveway aprons shall not be opened to vehicular traffic for at least 7 days after placement or until test cylinder breaks indicate an attained compressive strength of 2500 psi.

16) Backfill sidewalks flush with the surface of the walk and the surrounding ground line with soil. For detached sidewalks, backfill the area between the curb and the sidewalk on a straight line from the top of walk to the top of curb, but not to exceed a 4:1 slope.

7.5.2 Commercial Sidewalks

In addition to and including the above requirements for residential street sidewalks, commercial sidewalks within the City shall be constructed to the following requirements:

1) Driveway and alley approaches crossing the commercial sidewalks shall be a minimum width of 14 feet and the minimum concrete thickness of the approach slab shall be 8 inches. See standard drawings in Appendix for details. Granular base material for driveways shall be compacted base stone material conforming to Class A, Grading D of TDOT Section 303.02. A 2 inch lowered curb height above the gutter line shall also be maintained at the front edge of the driveway approach.

2) Isolation joints are required around penetrations in the sidewalk such as fire hydrants, utility poles, manholes, and adjacent to any fixed structure such as a building or retaining wall. Use 1" thick joints against buildings and retaining walls and 1/2" thick pre-molded non-bituminous expansion joint material shall be used in all other locations.

3) All valve boxes, manhole covers and other castings in the sidewalk area shall be adjusted to the grade of the sidewalk.

4) Commercial sidewalk widths shall be specifically reserved for pedestrian travel. Furniture, planters, newspaper stands and other protruding obstacles shall be kept clear of a minimum required width of 4 feet. Obstacles in the pedestrian path shall be eliminated or a widened pathway around the obstacle will be required.

7.5.3 Bikeways

Where desired, concrete bike paths within the City shall be constructed using the same requirements of commercial sidewalks except that Control joints shall be saw cut 1" deep through the concrete slab in lieu of tooled joints to improve rideability. Expansion joint material shall recessed 1/2" minimum below the riding surface.

7.5.4 Handicapped Ramps

All sidewalks within the City shall include North Carolina Accessibility Code, Volume 1-C, compliant handicapped access ramps at all intersections and crosswalks. Handicapped ramps shall be constructed in accordance with the City Standard Drawings.

1) Concrete for ramps to be Class A and shall be finished by light broom finish texturing.

2) Install a 1/2" pre-molded, rubber expansion joint between the ramp section and the sidewalk and between the ramp section and the curb.

3) Truncated dome detectable warning areas shall be installed using precast concrete paver units with integral domes as manufactured by Hanover Architectural Products or approved equal. Applied yellow plastic tactile products shall not be used.

7.5.5 Curb and Gutter Sections

All concrete curb and gutter sections shall be constructed in accordance with details shown in the Standard Drawings and the project plans. Curb openings will be located as shown on the approved plans and will be evaluated based on acceptable access control requirements by the City.

1) Class A Concrete shall be used for all curb and gutter sections and the concrete mix shall be air entrained.

2) Curb and gutter sections shall be constructed on compacted stone aggregate base for residential and commercial streets. Extruded curbs are to be constructed on asphalt binder course surfaces for residential streets.

3) Curb and gutter sections shall be reinforced with fiber filament mesh reinforcing.

4) Control joints for curb and gutter sections shall be spaced at a maximum of 10 feet.

5) Expansion joints are required at all tangent points in curved sections, between curbs and sidewalks and between curbs and other rigid objects such as buildings, catch basins and driveway aprons.

6) Where curbs are attached to the sidewalk, expansion joint spacing shall match the spacing of expansion joints in the sidewalk.

7) Maximum expansion joint spacing for detached curbs shall be 100 feet.

8) Curbs and gutters shall be constructed to follow the geometry of the roadway unless noted otherwise on the plans. Curved sections of curb shall conform to the roadway curve geometry with smooth continuous curves with no chorded portions.

9) Flow lines of gutters shall be true to line and grade with no areas of ponding water. Final longitudinal surface variations shall not exceed ¼ inch under a 12 ft straight edge.

10) Concrete finish for curb and gutter sections shall be a light broom finish with finish lines parallel to the flow of water.

11) Curb and gutter sections aprons shall not be opened to vehicular traffic for at least 7 days after placement or until test cylinder breaks indicate an attained compressive strength of 2500 psi.

7.6 Stamped Concrete and Brick Pavers

7.6.1 Stamped Concrete

For areas designated by the City, concrete finishing may incorporate imprinting or stamping and coloring of the exposed finish for improved aesthetics. Stamped concrete finishes are to be performed only by qualified contractors with a minimum of five years experience in commercial concrete stamping finishes. For projects with proposed concrete stamping, the proposed pattern, finish and color shall be submitted with related product data to the City Engineer for approval. Prior to construction, a mock-up sample of a minimum 4 square feet size shall be constructed to demonstrate a typical finished product for review and approval by the City.

Concrete stamped areas may include color of the final surface by applying a colored antiquing release agent just after initial set of the concrete. Concrete may also contain a color additive provided the colorant additive is mixed at the batch plant and the color is completely dispersed in the concrete. After concrete curing, the colored concrete surface shall be sealed with a clear sealer containing at least 30% solids in a minimum of two coats. Alternate method of coloring the concrete surface may be submitted to the City Engineer for approval.

7.6.2 Concrete Unit Pavers

While stamped concrete is the preferred method for aesthetic enhancement of concrete surfaces, concrete pavers may be used to create borders or bands within sidewalk areas. Pavers will not be allowed in areas subject to vehicular traffic unless otherwise approved by the City Engineer.

All paver units shall be concrete pavers installed over concrete mats with bituminous adhesives. Clay brick paver units shall not be used unless approved by the City Engineer.

7.7 Rigid Concrete Pavement

For specific locations on city streets with large volumes of truck traffic and damage to asphalt pavement due to braking forces, rigid concrete pavement may be utilized. Typical locations for its use include intersection approaches, particularly at the bottom of steep grades. Thin concrete overlay with thickness of 4 inches or less, commonly referred to as “white topping” and are constructed over existing hot mix asphalt shall not be used on City streets.

Minimum design requirements for new concrete pavements include a fiber reinforced, 8-inch concrete pavement thickness on 10 inches of compacted mineral aggregate base stone. Use of Class CP (3000 psi strength) concrete is a minimum requirement with the additional requirement of High Early Strength cement for a reduced construction time. Concrete pavement construction shall be in accordance with Section 501 of the TDOT Standard Specifications.

7.8 Concrete Reinforcement

Where indicated on the approved drawings, concrete for load carrying structures such as box and slab culverts, bridges and retaining walls shall be reinforced with steel bar reinforcement, welded wire fabric and pre-stressing strands. Sidewalks, curbs, combined curb and gutters and concrete pavement areas shall be reinforced with synthetic fiber reinforcement.

All steel reinforcing materials required for load carrying structures shall meet the requirements of the TDOT Standard Specifications unless noted. Sizes, spacing, gauges, locations and arrangements shall be as shown on the approved plans. Where project plans do not depict reinforcing placement plans or schedules, the contractor shall develop and submit reinforcing steel shop drawings to the City Engineer for approval. All hooked bars shall conform to CRSI standard hook details.

In the case of bridge decks, top slabs of box and slab culverts used as riding surfaces, concrete barrier rails and bridge sidewalks, all reinforcing steel shall be epoxy coated per the Standard Specifications. In addition, the dowel bars projecting from the footing into the back face (backfill side) of the wall stem in retaining walls shall also be epoxy coated.

7.8.1 Reinforcing Materials

Use the reinforcing materials below where indicated on the approved plans:

1) Steel Reinforcing shall be deformed steel bars conforming to ASTM A 615, Grade 60.

2) Steel reinforcement for bridge decks and top slab of box bridges when used as the riding surface shall be epoxy coated. All concrete bridge railing shall also require epoxy coated reinforcement.

3) Smooth steel dowel bars shall conform to ASTM A 615

4) Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

5) Prestressing steel shall be in accordance with ASTM A416

6) Synthetic Fibers (fiber reinforced concrete): Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

7.9 Concrete Placement

All formwork shall be constructed in accordance with the Standard Specifications using pre-manufactured metal forms or dressed form lumber and plywood. Formwork shall be adequately braced, mortar tight and true to line and grade. Provisions shall be made during placement of concrete to minimize aggregate separation and ensure proper consolidation throughout the pour. To highlight a few key requirements of Standard Specifications in particular, the contractor shall ensure the following placement operations are observed:

1) Elapsed time from truck loading to delivery and placement shall be limited to 90 minutes when the air temperature is 90 degrees or less. When the air temperature exceeds 90 degrees, this time is reduced to 60 minutes.

2) Concrete that does not meet the specified limits regarding slump, air content, temperature and delivery time shall not be used unless approved by the City Engineer.

3) Concrete shall be compacted with suitable vibrators operating within the concrete unless otherwise directed by the City Engineer.

4) Concrete may not be placed from a chute discharge height greater than five (5) feet.

5) No concrete other than foundation seals shall be placed underwater.

6) Do not add water to concrete during delivery, at project site, or during placement unless the concrete delivery ticket indicates that mix water was withheld at the plant. In such cases only the amount withheld per cubic yard may be added at the jobsite.

7) Concrete shall be placed in cold weather only when the air temperature is 40 degrees and rising.

8) Protect newly placed concrete from air temperatures below 40 degrees with insulation blankets to maintain the concrete temperature at not less than 45 degrees for a period of 120 hours after placement.

7.10 Inspection and Laboratory Testing

It is the contractor's responsibility to ensure quality concrete meeting the TDOT Standard Specifications is delivered and placed on the project. All quality testing of the concrete shall be performed by an independent testing company pre-approved by the City in accordance with Section 1 of these specifications. All quality testing performed by the testing agency is subject to monitoring and review by the City Engineer to ensure established procedures are followed. Reports of testing shall be certified and submitted to the City within ten days of actual testing to document the quality control before final acceptance of the project. The contractor will be responsible for the costs associated with all testing and also re-testing due to failed acceptance tests.

Required tests for concrete construction to be performed by the testing agency include:

1) Slump
2) Yield
3) Entrained air content
4) Mix temperature
5) Representative test cylinders

7.10.1 Testing Frequency

One composite sample (4 test cylinders) for each day's pour of each concrete mix exceeding 5 cu. yd. but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.

Concrete placement operations shall be inspected by an on-site superintendent to ensure placement of the concrete meets requirements of the Standard Specifications. On-site inspection is required to be documented by the contractor and recorded in a field book subject to review by the City Engineer.

CHAPTER 8

STRUCTURES

8.1 Overview

This Section includes all fabricated, installed and erected structures and appurtenances related to street construction including pipes, culverts, headwalls, box culverts, box and slab bridges, girder bridges, retaining walls and sign, signal and lighting supports.

8.2 Reference Specifications

Unless modified by these specifications, all structure materials and construction requirements shall conform to the "Standard Specifications for Road and Bridge Construction" published by the Tennessee Department of Transportation (TDOT) (latest edition).

8.3 Pipe Culverts and Storm Sewers

Pipe used for cross drains under the street or side drains under driveways shall be rigid concrete pipe. Pipe manufactured from corrugated metal pipe or ADS plastic pipe may only be used outside of the street right-of-way. Plastic and metal pipe may enter the back side of a street drainage structure provided it extends away from the street right-of-way or under a driveway and not under the street. All pipe culverts, side drains and storm sewers shall be furnished and installed in accordance with Section 204 and Section 607 of Standard Specifications.

Reinforced concrete pipe is standard for city streets

8.3.1 Concrete Pipe

Concrete Pipe shall be reinforced Class III rigid pipe and shall be round, oval or flat based as shown on the approved plans. All precast concrete pipe shall be manufactured in accordance with the “TDOT Procedures for Manufacture and Acceptance of Precast Drainage Structures, Noise Wall Panels and Retaining Walls”.

8.3.2 Corrugated Metal Pipe

Corrugated metal pipe shall be zinc-coated galvanized iron or steel pipe conforming to ASTM M36

8.3.3 Plastic and Polyethylene Corrugated Pipe

This pipe shall be ADS corrugated outside with smooth finish inside wall. This pipe may be used for site drainage, but shall not be used under streets or driveways. Plastic pipe may exit from the back side of a street drainage structure and extend off of the City ROW.

8.3.4 Pipe Bedding

Pipe bedding for concrete pipe shall be Class B, requiring a minimum of 6 inches of Class B granular stone below the pipe and shaped by a template to fit the lower part of the pipe exterior for at least 10 percent of its overall height. Pipe shall be properly backfilled in accordance with **Chapter 5**, Article 5.10.2.

8.3.5 Pipe sizes

Normal pipe sizes readily available from suppliers may be used to satisfy drainage requirements. Minimum pipe size for side drains and storm sewers shall be 15 inch diameter.

8.4 Pipe Culvert Endwalls and Inlets

Pipe culvert endwall treatments may be precast or cast-in-place concrete and are required for all pipe locations within the street right-of-way.


City standard endwall with safety grate

1) Endwalls for pipe diameters of 24 inches or larger shall be concrete construction in accordance with Type A or Type U endwalls as shown on TDOT standard drawings D-PE-1 and D-PE-4. Endwalls for 24 inch and larger pipes shall be fitted with a steel bar safety grate in accordance with the City standard drawings. Safety grates are required on inlet end only.

2) Endwalls for pipe diameters less than 24 inches shall be concrete construction in accordance with the straight endwall details as shown on the Standard Drawing No. SD-05. A soil subgrade cutoff wall is required to be cast integral with the headwall on pipe outlet ends only to prevent scour beneath the foundation. Type U headwalls may be used for pipe diameters of 24 inches or less if approved by the City Engineer.

3) To improve the aesthetics of pipe headwalls, textured concrete finishes simulating stacked stone may be used. Additionally, veneers of stone or brick may be applied to exposed surfaces to enhance the appearance from the street.

Straight endwall with stone veneer

8.5 Storm Drainage Structures

Storm drainage structures consist of junction boxes, drop inlets, catch basins and manholes which may be constructed as precast concrete sections or cast-in-place concrete.
Inlet and outlet pipes shall extend through the walls of structures a sufficient distance to make connections, but shall be cut flush with the inside surfaces of the box structure.

Vane grate for curb and gutter section

8.5.1 Catch Basin Castings

Catch basin castings that are damaged during construction will be rejected. Castings shall be set true to line and grade.
Standard catch basin grates in the City include:

1) Single Vane Inlet for Curb and Gutter Sections (Std. Dwg. SD-01A)

2) Single Vane Inlet for Extruded Curb Sections (Std. Dwg. SD-01B)

3) Drop inlet grates for area drains per TDOT Std. Dwgs.

8.5.2 Concrete Catch Basins

Standard catch basins are precast concrete or cast-in-place where directed by the Engineer. Catch basins are single and double concrete structures as shown on DWG SD-02. For excessive stormwater runoff areas or for areas requiring larger pipe sizes, the Curb Opening Inlet (Alabama Inlet) may be used. See standard drawing (SD-03).

8.5.3 Junction Boxes

Standard junction boxes for pipes where required may utilize single and double catch basin standard drawings by omitting the casting entrance in the top surface.

Triple catch basins and specialty junction boxes may be used for unusual conditions. Details for these structures may be designed and detailed on the plans or may be referenced to TDOT standard drawings. In either case, these special structures shall be submitted to the City Engineer for approval.

8.6 Street Curbs and Gutters

City standard details for combined curbs and gutters are shown in the standard drawings section of this manual. The standard sections include a vertical face combined curb and gutter and a mountable curb section with integral gutter.

Vertical combined curb and gutter

8.6.1 Post Curbs

Post curb sections without an integral gutter pan shall not be used unless approved by the City Engineer. Under no circumstances will they be used when water flows along the curb face.

8.6.2 Ribbon Curbs

Ribbon curb, which is typically 6 inches wide at the top and is cast near the asphalt surface, may be used in locations such as alleys and adjacent to medians where surface water runoff is conveyed over the curb to detention areas.

8.6.3 Standard Combined Curb with Gutters

The standard vertical face curb and gutter section consists of a 6-inch wide concrete curb cast integral with a 24-inch wide sloping gutter for a combined width of 30 inches. Combined curb and gutter sections with 18-inch wide gutter pans shall not be used unless an 18-inch vane grate to match the gutter width is submitted for approval by the City Engineer.

8.6.4 Spill Curbs

Where curb and gutter sections are used in superelevated streets and adjacent to medians, the gutter pan shall be sloped away from the median (“spill curb”) to allow sheet flow toward the drainage structures.

Rollover curb with grate transition

8.6.5 Mountable Curbs

The standard mountable curb or “rollover” curb is to be cast integral with a 12-inch wide gutter pan for a combined width of 24 inches. Vane grating for mountable curbs requires a width transition of the gutter pan to match the traffic edge of the drain casting.

8.7 Concrete Box and Slab Culverts and Bridges

Box and slab culverts are required when design flows exceed the hydraulic capacity of dual pipe structures or when a clear waterway opening is required.

Typical box bridge

8.7.1 Box culverts

Typically span 18 feet or less over water with single or double barrel box structures.

8.7.2 Box Bridges

Box bridges are defined as a box culvert type structure with a single box or multiple boxes, but having a total horizontal distance measured parallel to the street centerline of 20 feet or more between inside faces of the outside walls.

8.7.3 Slab Culverts and Slab Bridges

Slab culverts and bridges are differentiated the same as box culverts and box bridges, but are constructed without a bottom slab. Slab culverts and bridges are typically used when bedrock is within three feet or less from the streambed elevation.

8.7.4 Bottom Slab Placement

Box culverts and bridges are supported on a bottom slab foundation and may be founded on the natural gravel or sand streambeds. The top surface of the bottom slab of box structures shall be located a minimum of 2 feet below the natural streambed to allow for future streambed degradation.

8.7.5 Precast Bridge Units

Box and slab culverts and bridges may be precast or cast-in-place. Precast units speed construction times since only the foundations are required to be formed and poured in place and the units are set quickly on the foundations. Where aesthetics are to be considered, precast modular arch type units such as “Con/span” are available and often provide greater clear spans than precast box type structures. Both precast box and arch units may be used in multiple span arrangements to convey larger flows.

Con/span precast bridge

8.7.6 Riding Surface

Where practical, the top surface of the box culvert or bridge should be used as the riding surface of the street. The absence of fill material or asphalt placed on the top slab eliminates the detrimental effects of trapped moisture and extends the life of the concrete slab. Additional concrete thickness must to supplied to provide a clear concrete cover of 2 ½ inches over the top mat of reinforcing steel. When the top slab is used as the riding surface, the exterior curb portions of the standard box bridge designs should be omitted to allow surface water to drain off the slab. A bridge railing system of metal beam guardrail shall be thru-bolted to the top slab and extended off each end of the bridge. See TDOT standard drawings for details of the guardrail attachment.

8.8 Girder span bridges

Where larger water conveyance or grade separations are required, span type bridges are to be used with single or multiple spans of concrete or steel girders with cast-in-place concrete decks.

8.8.1 Design Requirements


Typical girder bridge

All span bridges shall be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Design of Highway Bridges (latest edition). Alternate designs using Load Resistance Factor Design (LRFD) methodology may be submitted for approval, and are required for TDOT funded projects after September 2007. Design drawings shall be sealed by a Professional Engineer licensed to practice in the state of Tennessee.

1) Vertical Clearances: Minimum vertical clearance from the lowest point of a bridge beam to the street surface below the same point shall be 14 feet-3 inches for local streets with infrequent truck traffic. Minimum vertical clearance for collector and arterial streets with more frequent truck traffic shall be 16 feet- 6 inches. Minimum vertical clearances for bridges over railroads shall be 23 feet above the top of rail.

2) Horizontal Clearances: Bridge abutment walls, abutment fill slope lines or interior support columns shall be located outside a minimum horizontal clear zone of 30 feet measured from the edge of the travel lane to the face of support. Where this clear zone is not possible as in the case of an existing bridge, a rigid barrier shall be placed in front of the bridge substructures and the face of such barriers shall project toward traffic a minimum of 6 inches beyond the bridge support. Horizontal clearances for bridges over railroads shall be 25 feet measured horizontally from the centerline of the track to the face of any bridge support face.

8.8.2 Bridge Type

The most economical bridge type for typical city streets is comprised of precast, prestressed concrete beams with cast-in-place concrete decks. Typical bridge lengths for single span concrete bridges range up to 120 feet with span lengths for multi-span bridges ranging up to 145 feet. Where geometric design constraints require longer individual spans, steel girder bridges may be designed with span lengths ranging up to 400 feet. The cost of steel fabrication labor and raw material cost increases are common factors reducing the ability of steel bridge to compete economically with concrete bridges. In many cases for small water crossings, it is more economical to provide single span girder bridges in lieu of multiple span box culverts since fewer substructures are required, construction within the water may be eliminated, and more clear waterway openings increase hydraulic efficiency while decreasing debris obstructions.

8.8.3 Vehicular Bridge Railings

Aesthetic bridge rail

Vehicular rail systems for city bridges include metal beam guardrail, concrete post and rail “open style” railings, and concrete sloped-faced continuous rails. All bridge rail systems shall be constructed in accordance with TDOT standard designs which have been crash tested and approved for use by the FHWA.
Metal beam guardrail systems should only be considered for low volume local streets with infrequent truck traffic. At all other locations, vehicular bridge rail systems shall be cast-in-place concrete. Bridges on high speed facilities in most cases should utilize a continuous slope-faced concrete rail or parapet system which is most commonly used on arterials and expressways and throughout the state. Bridge rail systems for lower speed streets may utilize the open face post and rail systems to more readily allow scenic views of rivers and stream crossings. The open face rail systems are also beneficial where floodwaters are allowed to overtop the roadway and bridge.

8.8.4 Pedestrian Combination Railings

Pedestrian and vehicular rail

For all bridges with sidewalks adjacent to the bridge railing at the bridge edges, the minimum height of the railing above the walking surface shall be 42 inches. Where multi-use paths allow bicycle travel adjacent to the bridge rail, the minimum height to the top of the rail above the riding surface shall be 54 inches. Standard drawings developed by TDOT for bridge rails adjacent to sidewalks which include aluminum handrails erected on top of a continuous concrete rail are to be used for most cases. It is recommended where practical to separate traffic from bridge pedestrians with vehicular rails and provide secondary pedestrian hand railing at the bridge edges. This allows more opportunities or aesthetically pleasing pedestrian railings while providing increase protection of pedestrians from traffic.

8.9 Pedestrian Bridges

Pedestrian Bridge

Pedestrian bridges for street overpasses, and greenway/bikeway paths over waterways are commonly used and are in most cases available in various design types from domestic suppliers of "ready-made" painted steel bridges. Other small bridges for greenways can consist of timber post and beam bridges. Pedestrian bridges supplied by manufacturers under trade names such as "Steadfast Bridge", "Continental Bridge" both produced by Contech Bridge Solutions or "US Bridge" are commonly steel truss type bridges with concrete or wood deck systems. In most cases, the contractor/ developer must supply the design and construction of the foundations for the pre-manufactured bridges, which are then delivered to the site, erected and set into place on the constructed foundations.

8.9.1 Clearances

Vertical and horizontal clearances are essentially the same as vehicular bridges with the exception that minimum vertical clearances over railroads or streets is increased by 12 inches over requirements for vehicular bridges.

8.9.2 Bridge Geometry Requirements

Clear widths between handrails for pedestrian bridges shall not be less than 10 feet and preferably 12 feet. Where required, approach access ramps or stairs shall meet the North Carolina Accessibility Code requirements for persons with disabilities and City Building Codes. Longitudinal slopes on pedestrian bridges should not exceed 5 % unless otherwise approved by the City Engineer.

8.9.3 Handrails

Minimum handrail height above the walking surface shall be 42 inches where bicycles are not allowed and 54 inches for bicycle facilities

8.9.4 Structure Type

Steel truss bridges with wooden decks are typically provided by specialized manufacturers; however, steel or concrete girder designs may be developed as alternates. Timber bridges may be used for short, low height pedestrian bridges over small ditches and creeks.

8.9.5 Design Requirements

Unless otherwise approved by the City Engineer, all non-timber pedestrian bridges shall be designed in accordance with the design criteria specified in the "Guide Specification for Design of Pedestrian Bridges" published by AASHTO. Design calculations and details shall be sealed by a professional engineer and plans shall be submitted to the City Engineer for review and approval. Smaller timber bridge designs shall meet the requirement of local building codes such as IBC. Where pedestrian bridges allow passage of maintenance vehicles and small trucks, loads shall be designed in accordance with AASHTO's Standard Specifications for the Design of Highway Bridges, latest edition. For bridges prohibiting maintenance vehicular traffic, provisions shall be made to restrict access by means of suitable barriers, bollards or other barricades.

8.10 Retaining walls

Earth retaining structures are often required to reduce the amount of right-of-way or encroachment of side slopes of street cross sections. This section is applicable only to walls located within the right-of-way.

MSE retaining wall

8.10.1 Design Requirements

All retaining walls requiring design heights of 6 feet or greater shall be design in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Design of Highway Bridges (latest edition) . Design drawings for retaining walls, regardless of height, shall be sealed by a professional engineer licensed to practice in the state of Tennessee.

8.10.2 Gravity Walls

Gravity wall designs which solely rely on dead weight of the wall to resist overturning due to earth pressure may be used for wall heights of 6 feet or less. Walls may be cast-in-place concrete in accordance with TDOT standard details. Gravity walls utilizing large stones or boulders shall not be used. Inspection for retaining wall construction is required by City Codes Department.

8.10.3 Cantilevered Walls

Cantilevered retaining walls which resist earth pressure with a reinforced stem cast integral with a spread footing below grade are typically used for wall heights up to 30 feet. Walls are to be cast-in-place concrete and shall be detailed to include a granular backfill drain system extending the entire length of the wall. For walls taller than 20 feet, the cantilevered stem wall should be cast in an inclined or battered position with the top of the wall inclined toward the backfill. This built-in camber will allow deflection of the top of the wall due to earth pressure which in the final state will result in a plumb wall surface on the exposed face.

8.10.4 MSE Walls

As an alternate to cast-in-place concrete walls, modular panel walls with steel straps utilized to reinforce the earth backfill are typically used for walls up to 40 feet. These modular unit walls which utilize the theory of mechanical stabilized earth (MSE) may be used.

8.10.5 Wall Finishes

For all retaining walls constructed within the right-of-way, the exposed surface of the wall shall have an architectural form liner finish unless otherwise approved by the City Engineer. The simulated form liner finish shall be a random ashlar stone pattern with the appearance of coursed limestone with random sizes. Form liner selection shall be submitted to the City Engineer for approval.

8.10.6 Railings

All retaining walls constructed within the street right-of-way shall be designed with consideration to the need for vehicular and or pedestrian railings. Vehicular rails on top fill walls shall be constructed with the same design utilized for bridge railings as provided on TDOT's standard drawings. Where a sidewalk is adjacent to the vehicular rail on a fill wall, a steel handrail design shall be used on top of the vehicular concrete rail. Where retaining walls retain a cut slope, consideration should be given to the possibility of pedestrian traffic adjacent to the top of the wall, which would require a 42 inch handrail for wall heights above the lower ground elevation of 36 inches or more.

8.11 Overhead Sign and Ground Mounted Sign Supports

Sign support structures are to be designed, fabricated and erected in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, latest edition. The contractor shall provide a design calculations and shop drawings sealed by a professional engineer licensed in the State of Tennessee for all overhead sign support structures.

8.11.1 Design Loadings

Basic wind speed for calculating wind pressure for all sign structures shall be 90 mph. Ice loading shall be 3 psf applied to one face of each sign and all surfaces of the support members. Dead load of the structure, signs and appurtenances shall be the actual calculated weights. Design of components shall be based on the maximum load combinations specified in the AASHTO standards.

8.11.2 Wind Area

To provide for future signs for overhead sign structures, the design wind area shall be calculated assuming a combined future sign width equal to the entire roadway width, not including shoulders. Sign wind area height for design shall be based on the tallest sign initially installed unless larger signs are anticipated in the future. For all cantilevered sign structures, all design criteria required in the AASHTO specifications for Category I fatigue loading shall apply.

8.11.3 Design life

Overhead signs shall be designed based on a 50-year design life. Ground mounted roadside signs shall be designed for a minimum 10-year design life.

8.11.4 Placement and Clearances

All sign posts and overhead sign structures shall be installed so as not to obstruct the motorist's view of the highway or other signs. In addition, posts shall not be installed in drainage ditches or in any way obstruct the flow of water runoff. Vertical and lateral clearances to sign edges shall be in accordance with the latest edition of the MUTCD. Wherever possible, large overhead signs should be installed outside the roadside clear zone. Where this clear zone placement is impractical, the support columns shall be protected by properly designed guardrail or concrete barriers.

8.11.5 Support Types

1) Ground mounted street signs shall be installed on perforated steel square tube posts as manufactured by Unistrut "Telespar" or of equal quality. U-channel type posts are not allowed. All ground mounted sign supports shall breakaway or yielding designs at their base. Posts shall be a minimum 12 gauge thickness, sized appropriately for the sign size and protected with a hot- dipped galvanized finish. Sign posts may also be finished with a powder coat paint finish for aesthetics in addition to the galvanized coating upon the approval of the City Engineer. Larger ground mounted signs requiring posts larger than two Telespar posts shall be designed and detailed in accordance with TDOT standard drawings and approved by the City Engineer.

2) Overhead sign structures may be overhead bridge types which span over the street or street-side mounted cantilevered structures. These larger sign supports are not considered breakaway compliant and must be protected from traffic. Spanning members and support columns may use single or box type trusses or monotube frame structures. All members and attachment components shall be structural steel and shall be painted with a System B paint system per TDOT Standard Specifications with the color of finish coat to be gloss black. A minimum of six anchor bolts are required for each support column at the foundation.

8.11.6 Foundations

Small sign posts shall be supported in the ground with telescoping anchors sleeves one size larger than the post and driven a minimum of three feet into undisturbed soil. The embedded sleeve shall not project more than 4 inches above the ground for a surrounding horizontal distance of 10 feet. Foundations for street signs larger than 9 square feet shall include a 12-inch diameter concrete foundation in accordance with TDOT standard drawings. Foundations for overhead sign structures may be concrete drilled shafts or spread footings properly designed for local soil conditions including allowable bearing pressure and passive soil resistance.

8.12 Traffic Signal Supports

Traffic signal support structures are to be designed, fabricated and erected in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, latest edition. The contractor and/or fabricator shall determine the size and design of all steel signal support poles and foundations. Shop drawings and sealed design calculations shall be submitted to the City Engineer for review and approval.

8.12.1 Design loadings

As with sign structures, basic wind speed for calculating wind pressure for shall be 90 mph. Ice loading shall be 3 psf applied to all surfaces of the signal heads and support members and one face of signs. Dead load of the signal heads, signs and appurtenances shall be the actual calculated weights. Design of components shall be based on the maximum load combinations specified in the AASHTO standards. The design of cantilevered traffic signal support poles, mast arms and foundation anchor bolts shall be designed for Fatigue Category 1 as required in the AASHTO Standard Specifications.
Signal support structures shall be designed based on a 25-year design life.

8.12.2 Placement and Clearances

Poles and controller cabinets shall be located clear of traffic turning movements and to maximize horizontal clear zones. When determining pole locations, consideration should be given to the possibility of future street widening so as to avoid future pole relocations. Pole and signal controller cabinet locations are to be coordinated with utilities to avoid conflicts and the final location shall be staked in the field and approved by the City Engineer before beginning installation. Traffic signal supports are not provided with breakaway supports and should be placed as far away from the street as practical. Pedestrian signal poles shall be designed with breakaway bases due to their proximity to the street.

8.12.3 Support Types

All traffic signal supports within the City shall be mast arm and pole type structures. Span wire assemblies with strain poles shall not be used unless otherwise approved by the City Engineer. All poles shall be steel tapered poles and shall be painted with a System B paint system per TDOT Standard Specifications or alternately powder coated with the color of finish coat to be gloss black.

8.13 Lighting and Luminaire Supports

Lighting supports and foundations within the City shall be in accordance with the accepted list of manufacturers and standard details compiled by Middle Tennessee Electric Membership Cooperative (MTEMC). The developer shall coordinate with MTEMC for the locations and installation of the proposed lighting supports and foundations. Alternate foundation designs that meet or exceed the specifications of MTEMC may be submitted for approval.

SIGNAL DESIGN

9.1 Introduction

The purpose of this chapter is to outline the City's review process for traffic signal plans and highlight basic design requirements for traffic signal installations and/or modernizations. This chapter outlines plan and design requirements for the various stages of review and also discusses some basic design elements the City requires on traffic signal projects.

Traffic signal technology changes at a rapid pace; the City reserves the right to change its traffic signal standards and specifications at any time without advance notice.

9.2 Administration

9.2.1 Signal Warrants

For the installation of traffic signals to be considered, the location must satisfy the warrants outlined in the most recent edition of the MUTCD. In high growth areas where significant changes in traffic conditions are expected due to the development of the area, hourly volumes for 5 years after full build-out should be estimated and compared with the MUTCD signal warrants. The growth rate utilized to estimate the future traffic volumes is subject to the review and approval of the City Engineer prior to its use. The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic signal. The City Engineer shall make the final recommendation regarding the location of any new traffic signal. For state routes within the city, TDOT will review and make final decisions regarding signal warrants.

9.2.2. Engineering Study

An engineering study will be required for all proposed traffic signal installations. The engineering study shall evaluate the effects of the proposed traffic signal on progression. The engineering study shall include the estimation of future volumes and an analysis of the progression of traffic through the signal system, as defined by the City Engineer. The evaluation shall include any planned future traffic signal installations. The analysis shall be submitted to the City Engineer for review and shall include capacity analysis (using Synchro, HCM Cinema or other software as approved by the City Engineer), as well as time-space diagrams of the signal system. The study periods shall be the AM, midday and PM peak hours, although other time periods may be required.

9.2.3. Signal Spacing

Signalized intersections shall be located to maintain progression of traffic along arterial streets. This normally entails relatively uniform spacing and sufficient distances between signals to allow vehicles to travel at reasonable speeds. Optimal spacing of traffic signals is always the desire of the City. The optimal spacing is a function of the cycle length and the progression speed of traffic along the major street, but a general guideline is that signals should be placed at least a quarter of a mile apart. New signal locations shall be subject to spacing requirements on a case by case basis as determined by the City Engineer. Proposed signal locations not adhering to this spacing will be reviewed. The spacing requirements may be waived if the City Engineer determines that the proposed traffic signal will not significantly hinder the progression traffic along the major street. If the proposed location is rejected, the City Engineer may require either the relocation of the proposed signal location, to better accommodate progression, or the evaluation of other alternatives, for management of the traffic generated by the side street / private access.

9.2.4. Private benefit signals

Private benefit signals provide signalized access to private streets or developments. These signals are generally required when the property owners must improve access from their site onto the major street or facilitate movement between developments on opposite sides of the street.

(1) Required Installations: If the Traffic Impact Study for a new development indicates that a traffic signal will be warranted within 10 years of full build-out, the City Engineer may require the inclusion of a traffic signal as a part of the development plan. The financial responsibility for these signals shall be in accordance with the arrangements made during preparation of the development plan. The time frame for installation is dependent on the traffic projections and subject to the discretion of the City Engineer. The site development plans will not be approved until provisions for the installation of the traffic signal or other alternative measures to enhance the safe movement of traffic through the intersection are included in the plans.

9.2.5 Designer Prequalifications

The design of traffic signals shall be performed by the City or a qualified Engineer approved by the City. The design staff for any firm supplying traffic signal plans to the City must be familiar with the traffic signal design procedures used by the City. At the request of the City, the design engineer may be required to provide copies of their most recent traffic signal design and / or modification projects to the City Engineer prior to their being assessed as qualified.

9.2.6 Intersection Design Study (IDS

An IDS must be prepared for any intersection that is proposed for the installation or modernization of traffic signals. Engineering work associated with the IDS will include topographical surveys, preparation of a base map, roadway geometric design, traffic signal layout and traffic signal phasing. The IDS shall include the traffic signal warrant study, detailed preliminary intersection and signalization design to meet present and future traffic needs, a list of needed rights-of-way, and a total project cost estimate suitable for budgeting purposes. An IDS that has been reviewed and approved by the City Engineer is required prior to the submittal of traffic signal plans for review. If an IDS does not exist for the intersection, one shall be prepared as part of the project presentation stage of design (described in the following section). If an IDS exists and, at the discretion of the City Engineer, the traffic conditions at the intersection have significantly changed since the preparation of the IDS, an update of the IDS may be required.

9.2.7 Project Reviews and Submittals

Traffic signal design work shall be submitted to the City Engineer on a staged basis. The City will record the dates of the submittal of each stage. The design requirements of each stage must be met prior to submittal of the next stage and all review comments supplied to the designer shall be addressed prior to the next stage review. The review stages and their requirements are as follows:

(1) Stage I - Project Presentation*:* For this stage, the designer shall present the scope of work as they understand it, the alternatives they have considered, and provide their recommendations for the extent and type of improvements. The following items shall be investigated and addressed by the design firm during this stage:

(a) Approved IDS or route design study
(b) Utility conflicts
(c) ROW parameters

(d) Geometric parameters and adjustments
(e) Drainage restrictions
(f) Emergency vehicle preemption
(g) Pedestrian indications/ pushbutton applications
(h) Combination lighting for the intersection
(i) Parking impacts and signing agreements
(j) Power service location and type
(k) Signal interconnection and impacts to adjacent signals
(m) Proposed controller location
(n) Proposed phasing
(o) Mast arm and signal head locations
(p) Type of detection
(q) Signing requirements
(r) Pavement marking, layout and proposed materials
(s) Existing equipment – removal or usage
(t) Temporary signal requirements
(u) Sight restrictions – horizontal / vertical curves
(v) Sidewalks including vaults if present
(w) Abnormal conditions
(X) Video camera applications.

(2) Stage II - First Review*:* A full-size set of plans shall be submitted approximately 50% complete. The following items, however, shall be included in complete form:

(a) Copy of letter to the power company requesting service on behalf of the City and notifying them of the project
(b) Temporary signal design, if necessary
(c) Removal item listing and proposed disposition
(d) Existing and proposed geometric design with roadway stationing
(e) Proposed pavement-marking plan
(f) Signal layout sheet
(g) Sequence of operation
(h) Preemption sequences
(i) Detection locations and proposed detection strategy
(j) Construction notes

Depending on the amount of intersection reconstruction involved in the project, the 50% plans should also address major concepts for the following items:

(k) Pavement design
(l) Storm sewer system size and layout
(m) Consider the need for sanitary sewer rehabilitation or construction
(n) Profile grade line
(o) Sidewalk grade
(p) Top of foundation elevations
(q) All other parts of the infrastructure that may be impacted by the project

(3) Stage III - Second Review*:* A full size set of plans shall be submitted together with specifications. The project shall be 95% to 100% complete. In addition to those items required in Stage II review, the following items must be included in this review:

(a) Schedule / Summary of Quantities
(b) Standard details and special details
(c) Legends
(d) Conduit sizes
(e) System interconnect plans (as needed)

(f) Pavement marking details
(g) Cover sheet
(h) Signing details

(4) Stage IV - Final Acceptance*:* The fully complete traffic signal plans shall have incorporated all previous review comments from the City and shall be checked by the designer prior to submittal to the City Engineer. The plan submittal shall include:

(a) One full-size plan set
(b) Two half-size plan sets
(c) Three sets of specifications
(d) For City funded projects, include cost estimate with pay code item numbers, quantities, units, and item abbreviations
(e) The designer shall retain original reproducible plans and shall produce copies of the plans at the request of the City, with the cost of reproduction paid by the City
(f) Electronic Copies of plans and specifications on CD-ROM

(5) Stage V – Construction, Inspection and Acceptance:

This stage of the project shall include:

(a) Preconstruction meeting
(b) Notification of ground work
(c) City staff inspection and punch list corrections
(d) Acceptance by the City Engineer
(e) Preparation of as-built plans

9.3 Design Standards

9.3.1 Referenced Standards

The design of traffic signals is under the jurisdiction of the City and shall conform to the requirements and specifications outlined in this chapter. Traffic signal design on State highways in the city shall meet the requirements of the City as approved by TDOT. All traffic signal design shall conform to the requirements of the MUTCD and the TDOT "Traffic Design Manual".

The following references shall be used in the development of signal phasing and timing in the City:

(1) Federal Highway Administration. *Manual on Uniform Traffic Control Devices.* Washington, DC: U.S. Department of Transportation, 2003.

(2) National Committee on Uniform Traffic Laws and Ordinances. *Uniform Vehicle Code,*. Millennium Edition 2000. Washington, DC: National Committee on Uniform Traffic Laws and Ordinances.

(3) Institute of Transportation Engineers. *Manual on Traffic Signal Design,* 2nd Ed. Washington, DC: James H. Kell and Iris J. Fullerton, ed. Institute of Transportation Engineers, 1998.

(4) Institute of Transportation Engineers. *Determining Vehicle Signal Change and Clearance Intervals.* Washington, DC: Institute of Transportation Engineers, 1994.

(5) Institute of Transportation Engineers. *Traffic Engineering Handbook,* 5th Ed. James L. Pline, ed. Institute of Transportation Engineers, 1999.

(6) Tennessee Department of Transportation, *Traffic Design Manual,* latest edition.

Typical signal installation

9.3.2 Design Requirements:

(1) Proposed locations for traffic signal installations must be warranted under current conditions according the Manual on Uniform Traffic Control Devices. For new development, traffic signals must be warranted upon a 5-10 year build-out. Installations that are not warranted by traffic conditions will not be considered.

(2) Eagle EPAC Controller and Cabinet Types 3-5 wired for a full 8 phase with 4 overlaps operation with the latest version of EPAC Software is required.

(3) City standard spread spectrum radio with antenna and complete wiring, including modem card in the controller, is required, where approved by the City Engineer.

(4) Opticom fire preemption system complete with detectors, wiring, and card in the cabinet (3M system) is required, where approved by the City Engineer. Emergency vehicle preemption is required along emergency response routes

(5) Pedestrian signals and pushbuttons shall be provided at the discretion of the City Engineer. The international symbols for ‘walk’ and ‘don’t walk’ shall be specified for all pedestrian signal indications. Countdown timers for pedestrian signals may be submitted for approval by the City Engineer if agreed to be funded by the developer.

(6) LED indications shall be specified for all vehicle indications and pedestrian indications.

(7) Loop detectors complete with wiring and detector circuits for counting traffic shall be used on all approach lanes except for exclusive right turn lanes that will operate with recall phases. Video detection shall be approved on a case-by-case basis as approved by the City Engineer.

(8) In addition to advance detector loops in the thru lanes of moderate and/or high speed approaches (35 mph or greater), system loops shall be installed in the opposite direction thru lanes at the same location (subject to lane restrictions) as the advance loops where feasible.

(9) Signal indications on mast arms shall line up with the center of the lane the indication is intended for. An exception is that the left turn indication on the mast arm may be lined up over the right lane line of the left turn lane.

(10) Combination mast arms and other equipment necessary to provide intersection lighting may be considered part of a traffic signal installation and are allowed at all new traffic signal installations and modernizations. Aluminum and painted mast arm/signal poles, luminaire arms, and extensions shall be used. Painted poles and arms shall be per City specifications.

(11) Any street light luminaire extensions (aluminum and painted) shall be approved by the City Engineer. A minimum 30-foot luminaire mounting height and a minimum 15-foot luminaire arm (aluminum and painted) shall be used to mount the streetlight fixture. The attachment height for mast arm to pole shall be per approved shop drawings.

(12) Black or yellow, 3-section aluminum signal heads with 4” black back plates shall be mounted using astro-brackets over the center of each lane. Side-of-pole mounted 3 or 5 section heads may be used on the near and/or far side right corner, which will control any dedicated right turn lanes. Use of far-side left 3 or 5 section heads are determined on an intersection by intersection basis but will be used in most cases on State Highways or Arterials with significant large truck traffic.

(13) Black or yellow 16-inch LED pedestrian heads (hand/man) with visors and a clamshell/banding mounting system are required, with ADA pedestrian buttons for all standard pedestrian movements with marked crosswalks.

(14) Pedestrian buttons shall be the bulldog type with audio alert, LED light, and sign housing/back plate. The accessible push button system (APS) shall be used only where approved by the City Engineer. Further information on pedestrian push buttons is provided in Section 9.3.8.

(15) Two 3-inch conduits (Schedule 80 PVC minimum) will be used for wiring between the signal bases and the cabinet. For vehicle loops, a 1-inch minimum conduit size shall be used from the loop wire pavement feed to the nearest pull box.

(16) For City funded projects, all shop drawings for signals are to be approved by the City Engineer prior to installation.

(17) Provide a minimum 1.5 inch diameter conduit for loop lead-ins for better accessibility.

(18) Include provisions for new streets and widening projects to include conduit for future signal interconnects and pullboxes as required.

Typical cantilevered mast arm structure with luminaire

9.3.3 Traffic Signal System Requirements:

(1) The installation of a fiber optic interconnect is required between signalized intersections that are within 1/2 mile of one another or if analysis indicates that the signals would benefit from signal coordination. When an interconnect is required a master controller and communications interface must be installed as a part of the project if one does not exist already.

(2) The City Engineer may require the installation of detection for the purpose of collecting traffic counts.

9.3.4 Electrical Requirements:

(1) The traffic signal design shall conform to the National Electric Code.
(2) Traffic signal equipment shall conform to NEMA standards.
(3) Fiber optic interconnect shall include a copper tracer in the conduit for locating purposes and the location of the fiber shall be marked periodically.
(4) Power back up may be provided at locations required by the City Engineer, with the ability to provide stop-and-go control for up to one hour.
(5) Combination mast arms may be specified in order to provide intersection lighting. Intersection lighting may be considered part of a standard traffic signal installation in the City.
(6) The traffic signal plan shall include a continuous grounding plan for the intersection.
(7) Double handholes are required at all traffic signal cabinet locations.
(8) Power disconnects shall be provided.
(9) New power installations shall be continuously metered by MTEMC.

9.3.5 Construction

Traffic signal installations / modernizations shall be constructed in accordance with applicable sections of the TDOT Standard Specifications for Road and Bridge

Construction, the TDOT Standard Specifications for Traffic Control Items, and the City Standard Specifications for Traffic Control Items.

9.3.6 Materials and Construction Notes

The specifications for traffic signal equipment and related appurtenances required by the City are maintained by the Engineering Department. A copy of these specifications is included in the Appendix.

9.3.7 Pedestrian Signals & Timings

The MUTCD identifies the situations in which pedestrian signal shall be used and the situations in which pedestrian signals should not be used. Because one should assume that pedestrians will be present at all intersections in the City to some level, all signalized intersections should be designed to accommodate pedestrians. Other locations that have high pedestrian volumes with marked crosswalks may also warrant the installation of a dedicated pedestrian actuated traffic signal, subject to review and approval by the City Engineer.

The MUTCD and the *ADA Accessibility Guidelines for Buildings and Facilities* should be consulted regarding pedestrian signal timings. However these documents contain some differences. Each of these documents should be reviewed, and the most stringent requirements should be applied when designing pedestrian signal timings. Pedestrian signals should utilize universal symbolized messages, as outlined in the MUTCD, rather than letters. The MUTCD uses the term “Walking Person” to describe the white illuminated figure that symbolizes the WALK interval. The “Upraised Hand” is used to describe the orange illuminated figure that symbolizes the DON’T WALK interval. According to the MUTCD, a minimum of seven seconds should be allocated to the WALK signal. The amount of time dedicated to the DON’T WALK signal should be based on the pedestrian walking speed and the crossing distance. According to ADA Accessibility Guidelines for Buildings and Facilities, a pedestrian walking speed of 3.5 feet per second should be assumed at all intersections. This document also states that the crossing distance should equal the length of the crosswalk plus one sidewalk ramp.

9.3.8 Pedestrian Push Buttons

Pedestrian pushbuttons should be used at pedestrian crossings that have low, intermittent pedestrian volumes. The design and placement of pedestrian pushbuttons should meet the following criteria:

(1) The pushbutton should be located a maximum of five feet away from the extension of the crosswalk lines and within ten feet of the curb/shoulder/ pavement.

(2) If two pushbuttons are located on the same street corner, they should be separated by at least ten feet.

(3) The pushbutton shall be accessible to a person in a wheelchair on the level landing at the top of the sidewalk ramp.

Typical pedestrian push button

(4) The pushbutton box should face the pedestrian standing at the curb on alignment with the crosswalk.

(5) An arrow should clearly indicate which crosswalk will be affected by the pushbutton.

(6) Standard pedestrian signal instructions should be mounted near the pushbutton.

(7) A pushbutton should be present at each leg of a signalized intersection that does not have a fixed-time pedestrian phase.

(8) The pushbutton should include an illuminated confirmation light to acknowledge that a call has been detected.

(9) At intersections with known handicapped crossing activity, accessible pedestrian signal equipment shall be used.

9.3.9 Bicycle Signal Timing and Detection

Bicyclists are required to follow the rules of the road, including those related to traffic signals. Therefore, signal timing and detection should accommodate the needs of bicyclists. Traffic signal clearance intervals are recommended to be timed to provide bicyclists with sufficient time to react, accelerate, and proceed through an intersection on the clearance interval. Normally, a bicyclist can travel through an intersection under the same signal phasing arrangement as motor vehicles. However, special consideration of bicyclists' needs may be necessary at multi-lane crossings and at acute angle intersections, which take longer to cross. The clearance interval should take into consideration a bicyclist's speed of 6-8 MPH, and a perception/reaction/braking time of 1.0 second. Traffic detectors for traffic-actuated signals are recommended to be set to detect bicycles.

There are various types of detector loops that can be used. Quadruple and diagonal quadruple loop detectors generally provide for bicycle detection, unlike standard loops, which are difficult to adjust to detect bicycles. Detectors should be located in the bicyclist's expected path of travel. When bicycle lanes are not present, pavement markings should be used to indicate where bicyclists should position themselves in order to activate the signal detector.

9.4 Signal Phasing and Timing

9.4.1 Purpose

The City has adopted a set of traffic signal timing and phasing guidelines which are to be implemented at signalized intersections under their jurisdiction. The purpose of these guidelines is to establish standard practices and operational procedures for traffic signal timing parameters to be used by City staff and consulting engineers performing signal timing services for City. This policy is in no way in conflict with the Federal Highway Administration's *Manual on Uniform Traffic Control Devices* (MUTCD). Should a conflict arise, the MUTCD shall prevail.

The guidelines in this document are to be implemented at new traffic signal installations, traffic signal upgrades, and along signalized corridors as they are re-timed. The adoption of these guidelines does not imply that each and every traffic signal under the jurisdiction of the Engineering Department will automatically comply with these new guidelines. Rather, traffic signal settings will be updated along signalized corridors throughout the City as they are retimed.

These guidelines have been established to provide guidance on various signal timing parameters. However, signal timing should be evaluated for all situations independently based upon standard traffic engineering principles and local intersection characteristics. Necessary adjustments should be made to meet the traffic conditions at each individual signalized intersection. These guidelines should serve to provide consistent, safe, and efficient control of traffic signals within the City.

9.4.2 Vehicle Clearance Intervals

The MUTCD requires that vehicle clearance intervals consist of a required yellow change interval and an optional red clearance interval. The MUTCD defines both the yellow change and red clearance intervals as:

> *Yellow Change Interval – the first interval following the green interval during which the yellow signal indication is displayed.*
>
> *Red Clearance Interval – an optional interval that follows a yellow change interval and precedes the next conflicting green interval.*

The timing of Yellow Change and Red Clearance intervals are to be established per the ITE Recommended Practice.

9.4.3 Pedestrian Control Features

There are a number of pedestrian-related items that are covered in this portion of the guidelines. They include recommended pedestrian walking speeds, minimum pedestrian walk intervals for pedestrian signal phasing, guidelines for pedestrian clearance intervals. The City adheres to MUTCD recommended standards for pedestrian timing.

9.4.4 Pedestrian Push Button Usage

Pedestrian push button actuation is recommended for pedestrian phases that cross the 'main street' approaches so that 'side street' vehicle phases do not have to accommodate pedestrian timings unless they are actuated via a pedestrian push button. The need for push button actuation to cross side street approaches shall be determined via engineering judgment by the City. For the purposes of determining main street approaches in reference to pedestrian timings, the main street approaches will be considered the signalized approaches that are coordinated and are therefore non-actuated. If a traffic signal is pre-timed or fully-actuated, the differentiation between main street and side street does not apply for this situation.

9.4.5 Walk Rest Modifier Option

During main street vehicle signal phases that are non-actuated, there are often situations where the vehicle split is significantly larger than the required pedestrian walk and clearance intervals. Rather than increasing the pedestrian clearance interval to accommodate the additional time available, City staff will allow the signal controller to extend the length of the pedestrian walk interval. There are however, situations where this option, known as the walk rest modifier, should not be allowed. Such applications where the walk rest modifier should not be utilized include the following: (a) cases where right-turn volumes are heavy across the pedestrian crossing area, (b) cases where permissive left-turn volumes are heavy across the pedestrian crossing area, and (c) any other cases where City staff has determined that the walk rest modifier option should not be implemented.

9.4.6 Minimum Vehicle Green Times

Minimum vehicle green times should be short enough so that green time is not wasted, yet not so short such that motorists unexpectedly see the yellow change interval while entering the intersection and become confused. The minimum times documented in this section of the policy are the minimum allowed which does not suggest that all signalized intersections will utilize these minimum values. Greater minimum green times are allowed; however values lower than these mentioned below are not recommended. In addition, the percentage of trucks should also be reviewed on an intersection-by-intersection basis since a high percentage of trucks may necessitate increasing the minimum green time controller setting. Maximum green time setting are not discussed in this policy since they vary significantly by location and are based on signal operation, vehicle demand, and other operational characteristics.

Minimum Green Times for Left-turn Phases **-** A minimum green time setting of four (4) seconds is allowed for left-turn phases.

Minimum Green Times for Side Street Through Phases **-** A minimum green time setting of seven (7) seconds is allowed for side street phases.

Minimum Green Times for Main Street Through Phases **-** A minimum green time setting of ten (10) seconds is allowed for main street through phases.

9.4.7 Main Street and Side Street Definitions

It is often obvious, when comparing approach geometry, traffic volumes, road classification and/or route continuity, which roadway is considered the 'main street' and which is considered the 'side street'. However, there are instances where there is no clear cut distinction between the two. Some intersections include two main streets. For the purposes of selecting minimum green time settings, the City Engineer will apply the above factors in determining whether or not a main street approach exists.

9.4.8 Left-Turn Signal Phasing Guidelines

Left-turn phasing guidelines as discussed in the ITE *Traffic Engineering Handbook* are to be used for assistance in assessing the need for left-turn phasing at signalized intersections under City jurisdiction. There are two Transportation Research Record documents suggested by ITE for traffic engineers to consider where determining the need for some form of protection for left turn phases. They are:

From J. E. Upchurch. Guidelines for Selecting Type of Left-turn Phasing. In *Transportation Research Record* 1069, Transportation Research Board, National Research Council, Washington, D.C., Figure 5, p. 37.

From Asante, S. A., S. A. Ardekani, and J. C. Williams. Selection Criteria for Left-Turn Phasing and Indication Sequence. In *Transportation Research*

Record 1421, Transportation Research Board, National Research Council, Washington, D.C., 1993, Figure 4, p. 17.

These guidelines shall be used as a tool for determining the need for left-turn phasing at signalized intersections along with engineering judgment by the traffic engineer.

In addition to the guidelines referenced above, there are two additional guidelines that are to be adopted as City policy:
(1) Exclusive/permissive left-turn signal phasing is allowed when three (3) opposing through lanes exist as long as there is no accident experience problem and/or sight distance issue that would hamper the safety of permissive left-turn movements.
(2) Exclusive left-turn signal phasing shall be installed where multiple left-turn lanes exist.

9.4.9 Protected/Permissive Left-Turn Phase Operation

Phasing for eight-phase signal controllers should prohibit a phase change from main street green to a main street left-turn phase if it the left-turn phase operates protected/permissive. In the absence of a side street actuation, the signal controller should remain in main street green to allow left-turn movements to occur on the permissive green.

9.4.10 Split-Phase Timing Operation Guidelines

The term split-phase signal operation describes a signal phasing sequence where one approach is given exclusive right-of-way into the intersection followed by the opposing approach being provided exclusive right-of-way into the intersection. This operation eliminates left-turn conflicts; however, it is often described by traffic engineers as an inefficient signal phasing option since the entire intersection is given a red indication to service only one of the four signalized approaches. Nonetheless, there are situations where its use should be considered. For traffic signals under the jurisdiction of the City, the following situations may necessitate the need for split-phase timing operation:

(1) Where offset approaches exist that may cause motorist conflicts/confusion if permissive phasing were implemented.

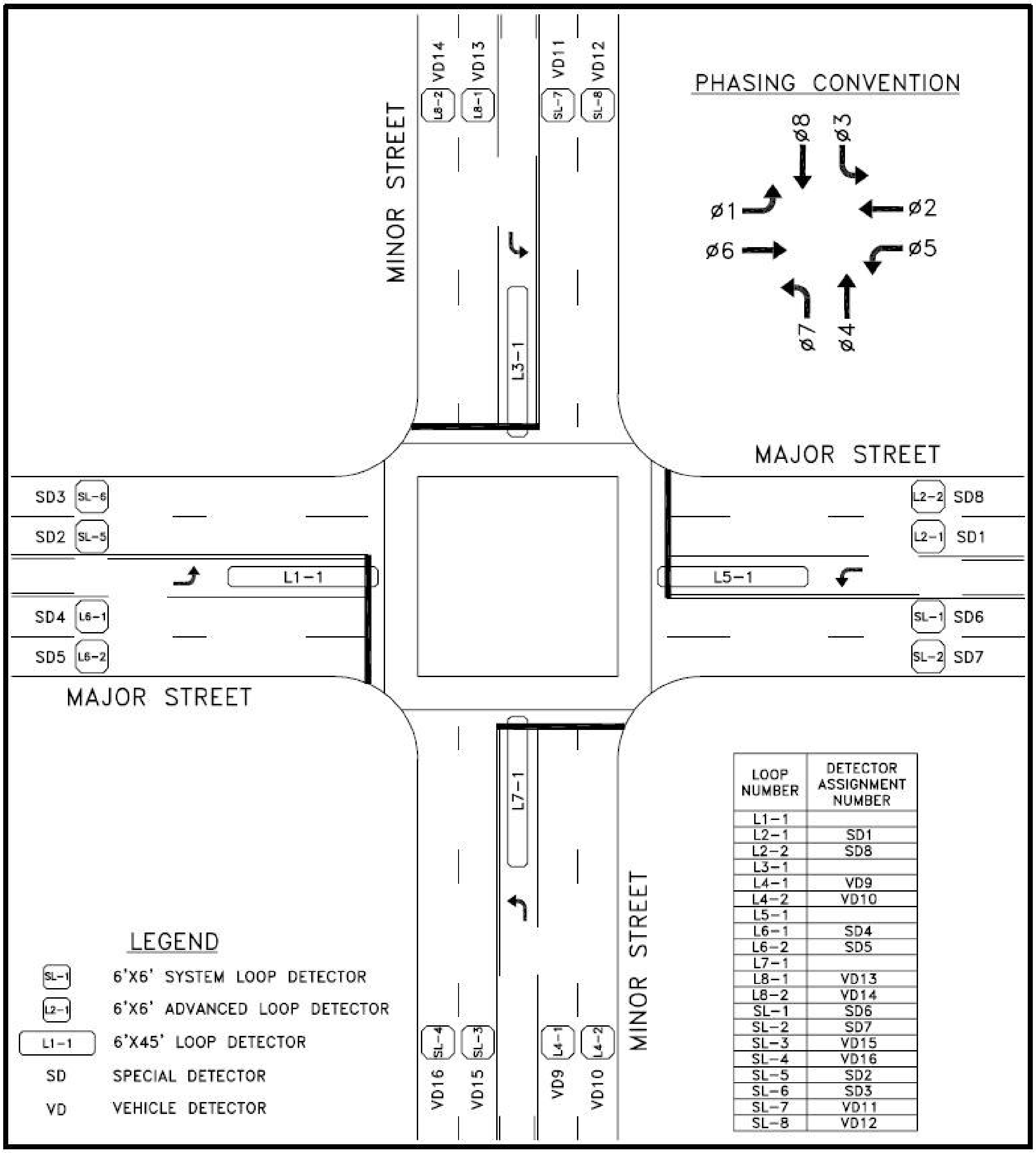
(2) Where intersection width prevents opposing left turn movements from operating concurrently. Prior to implementing split-phase operation due to this geometric limitation, the installation of lead-lag phasing should also be considered.

(3) When an accident problem exists between left-turn and through movement conflicts that has not been successfully remedied via other operational improvements.

(4) Where a sizeable volume imbalance exists on the side street approaches.

(5) Where a second left-turn lane is needed but must be shared with a through movement lane.

(6) Where the need to serve the left-turn volume is relatively close to the time needed to serve the through movement volume. For each case, a capacity analysis should be performed comparing split-phase timing operation versus other signal phasing options prior to implementation.



Typical Detector Numbering and Phasing Convention

Street Lights

10.1 General

Adequate lighting shall be provided to ensure safe movement of persons and vehicles in the public right-of-way, and to assist for security purposes. The primary purpose of streetlights are to illuminate the public traveled ways to a level that provides for the safe passage of public traffic, both vehicle and pedestrian.

10.2 Guidelines

10.2.1 Design: All street lighting of public streets in the City will be designed in accordance with these Standards.

10.2.2 Type: Public lighting poles or light standards shall be of a type approved by the Middle Tennessee Electric Membership Corporation (MTEMC). The final installation location and quantity of all street lights shall be determined by MTEMC.

10.2.3 Uniform lighting: Lighting will be used on new street projects involving Arterial and Collector streets. The guidelines shall be the AASHTO Roadway Lighting Design Guide and the Design Manual of the Tennessee Department of Transportation, most recent edition and supplemental revisions or guidelines approved by the City. All fixtures, poles, and designs will be reviewed and approved by the power provider.

10.2.4 Glare Prevention: All lighting fixtures shall be designed or shielded to prevent glare, and to minimize light shining on or negatively affecting neighboring residents.

10.2.5 Illumination: Lighting shall be designed to have the intensities and uniformity ratio consistent with the AASHTO Roadway Lighting Design Guide for the roadway classification under consideration.

10.2.6 In Landscaped Areas: Poles may be located within landscaped areas or islands; however, to avoid conflicts with required trees, the location of poles shall yield to existing mature trees. Proposed trees shall be relocated to avoid conflicts with light standards.

10.2.7 Restrictions: No luminaries shall have any blinking, flashing or fluttering lights or other illuminating device which has a changing light intensity, brightness or color, nor is any beacon light permitted, except those required for fire alarm and/or emergency systems.

10.2.8 Light color: Light color shall be “white” light, generally provided by metal halide fixtures. Other lamp options, including, but not limited to, color-corrected mercury-vapor, color-corrected high-pressure sodium and low-pressure sodium, may be approved by the City Engineer on a case-by-case basis.

10.3 Responsibility

10.3.1 Developer: The Developer shall coordinate all aspects of design and installation of new or upgraded street lighting. All street lighting of public streets in the City will be designed and installed in accordance with these Standards for lighting. Exceptions to reduce lighting requirements may be approved by the City Engineer for parts of developments bordering rural areas.

10.3.2 Costs: The City will be responsible for all costs involving the material and installation of street lights on City-funded projects involving arterial and major collector streets. The Developer will be responsible for all costs involving the design, material, and installation of street lights on street improvements not funded by the City.

10.3.3 Compliance: The subdivider, developer, or property owner(s) is responsible for complying with the requirement to install street lighting and shall make all necessary arrangements with MTEMC for the installation of streetlights and bear all costs relating to the purchase and placement of streetlights. Installation of street lighting materials shall be performed by a Tennessee licensed contractor also having any required local business licenses prior to commencing any work.

10.3.4 Plans: Street lighting plans are to be prepared by MTEMC and shall be submitted by the developer or property owner(s) with the improvement plans to the City Engineer for review. Such plans shall show the location of each light, power source, and size of luminaries in watts or lumens. All street lighting shall meet MTEMC standards.

10.3.5 Acceptance: All street lighting within each construction phase shall be complete and operational prior to acceptance of subdivision public improvements.

10.3.6 Requests: Requests for street lighting in previously developed areas must be approved by the City Engineer for location and installation prior to being submitted to MTEMC for design engineering.

10.4 Underground Service

10.4.1 Installation: Street lighting shall be installed with underground electric service on all newly developed dedicated public streets in the City. Curb returns shall be installed after the installation of the electrical system, including underground vaults. The Developer is responsible for coordinating with MTEMC for all aspects of design and installation.

10.5 Layout Criteria

10.5.1 Mounting Height: Streetlight mounting height in residential areas shall be as determined by the Zoning Ordinance and MTEMC. The designer should refer to MTEMC Standards for height and try to maintain minimum spacing. In areas other than residential, the mounting height shall not exceed 40 feet for arterial and collector streets. Expressway lighting mounting heights shall not exceed 60 feet unless high mast lighting at interchanges is required.

10.5.2 Spacing:

(1) Street lights shall be placed between intersections and at mid-block locations such that a minimum spacing of three hundred fifty feet (350') and maximum of five hundred feet (500') is maintained between all lights.

(2) Local residential streets shall have one light at each intersection.

(3) If the intersection lights would exceed 500 feet apart on a straight street, mid-block lights shall be added so lights do not exceed 500 feet spacing. If the street has a curve, judgment shall be used to reduce the spacing to less than 500 feet.

(4) Where possible, streetlights shall be staggered on alternate sides of the street. However, for "T" intersections, the light should be located on either corner of the intersection of the street that ends.

10.5.3 Intersection Locations: In general, the nighttime visibility of a pedestrian or hazardous object within an intersection is enhanced by increased contrast between the object and the surrounding street area. The optimum contrast (and hence safety) is achieved when the street lights are situated to silhouette (or backlight) objects in the intersection. Therefore, street lights at intersections are required to be placed on the downstream side of the intersecting street, as viewed by a motorist approaching the intersection in the lane directly beneath the luminaries. See Figure 10.5.3. The positioning of light standards at intersecting streets shall be as noted in Table 10.5.3.

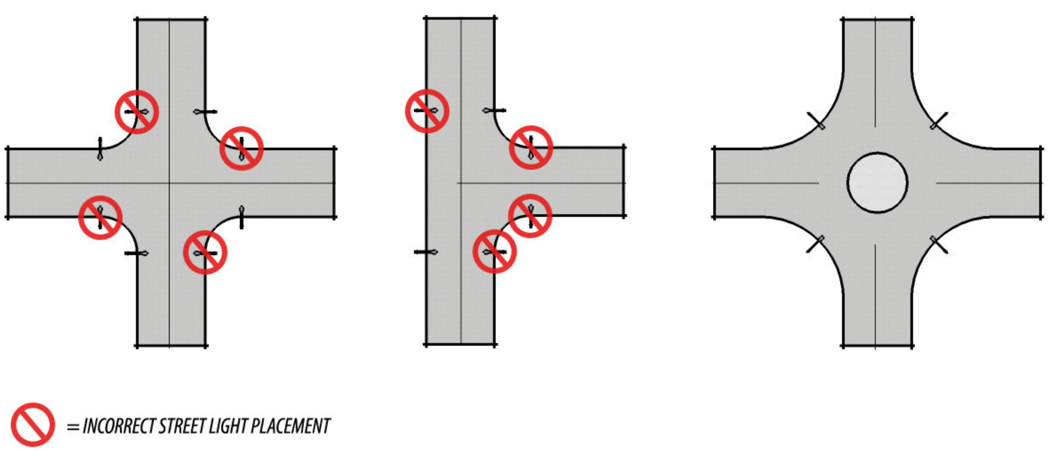


Figure 10.5.3 – Guidelines for Location of Luminaries for Various Intersection Types

	Number of Lights	Position
Arterials/Major Collectors	4	One in each corner
Arterials / Arterials	4	One in each corner
Collector / Collector	2	One on opposite corners
Local / Collector	2	One on opposite corners
Local / Local	1	On one corner
Sharp Curves or End of Cul-de-Sac	1	Place for maximum coverage

Table 10.5.3 – General Guidelines on Number and Position of Luminaries

10.5.4 Signalized Intersections: Signalized intersections may be lighted using combined streetlights and mast arms or stand alone light standards. Mounting of signals will be perpendicular to the flow-line.

10.5.5 Roundabout Lighting: Lighting columns should be arranged around the perimeter of the roundabout in a simple ring, with the lights equidistant from the center and from each other. Lighting should extend at least 200 feet back along each approach street. Mounting height should be uniform throughout the intersection and not less than on any approach street. The minimum luminance required should not be less than the highest level of lighting for any of the approach streets.

10.5.6 Railroad Crossing Lighting: Railroad crossing lighting will conform to the latest version of the Railroad-Highway Grade Crossing Handbook (FHWA).

10.5.7 Lighting in Undercrossings: All bridge underpasses, where vehicles, pedestrians, bicyclists, or equestrians may be present, shall require lighting.

10.5.8 Attached Sidewalks: Where sidewalks are attached to the curb, street lights should be installed behind the sidewalk (in right-of-way or easement) with at least 1 foot clearance on Local streets (2 feet clearance on Major Collectors and Arterials). Poles within the clear zone shall be breakaway designs.

10.5.9 Detached Sidewalks: For sidewalks detached from the curb, street lights should preferably be located between the curb and sidewalk and installed a minimum of 2 feet from the back of curb, and 2 feet clear from all walks (1 foot on Local Streets). Poles within the clear zone shall be breakaway designs. See Fig. 10.5.4.

10.5.10 Non-Curbed Streets: On streets without curb and gutter, street lights should be place no closer than ten (10) feet to the edge of the traveled way. Poles within the clear zone shall be breakaway designs.

Fig.10.5.4 Typical lighting at detached sidewalk

10.5.11 Street Lighting in Medians

Street trees shall not be placed within 40 feet of a street light. Understory trees shall be no closer than 15 feet to any street light. Poles within the clear zone shall be breakaway designs.

Fig. 10.5.5 Typical median lighting

10.6 Light Levels

10.6.1 General: All lighting shall have the intensities and uniformity ratio consistent with the *AASHTO Roadway Lighting Design Guide* and shall be designed and located so that the illumination measured in foot-candles at the finished grade shall comply with the standards in Table 10.6.1, Minimum and Maximum Illuminance Values. The illumination shall take into account road surface classifications (R-Class). For most cases, R3 and R4 classes will be applicable.

Table 10.6.1: Average Maintained Illuminance Values (in Foot-candles)				Uniformity Avg./min
Classification	**R1 (concrete road surface)**	**R3 (Asphalt surface with rough texture)**	**R4 (Asphalt surface with smooth texture)**	
Expressway	**0.9**	**1.3**	**1.2**	**3:1**
Arterial	**1.1**	**1.6**	**1.4**	**3:1**
Collector				**4:1**
(commercial)	**0.7**	**1.1**	**0.9**	
(intermediate)	**0.6**	**0.8**	**0.7**	
(residential)	**0.4**	**0.6**	**0.5**	
Local	**0.6**	**0.8**	**0.7**	**6:1**
(commercial)	**0.5**	**0.7**	**0.6**	
(intermediate)	**0.3**	**0.4**	**0.4**	
(residential)				

10.6.2 Uniformity Ratios: In order to maintain uniformity in light levels across a street or minimize dark areas, the ratio of average to minimum lighting levels on a given street as measured in foot-candles at street level, shall not exceed the values given in Table 10.6.1.

10.7 Hue: Color-corrected high pressure sodium, and low-pressure sodium are allowable forms of exterior lighting. Metal halide lighting may be used as approved by the City Engineer in special cases.

10.8 Installation

10.8.1 General: The developer or property owner(s) is responsible for complying with the requirement to install street lighting and shall make all necessary arrangements with MTEMC for the installation of streetlights and bear all costs relating to the purchase and placement of streetlights. Installation of street lighting materials shall be performed by a Tennessee licensed contractor also having any locally required business licenses prior to commencing any work.

10.8.2 Order: Underground electrical installation shall not begin until after curb and sidewalk is installed, unless other arrangements have been made with MTEMC. Curb returns shall not be installed on any street until after electrical installation, to facilitate the installation of underground vaults and other facilities.

10.8.3 Coordination: The Developer is responsible for coordinating with MTEMC for all aspects of design and installation.

10.8.4 Drawings: Drawings for installations will be prepared by the Developer with assistance from the power provider and approved by the City Engineer prior to installation. In new subdivisions, a street lighting plan will be required prior to approval of the subdivision.

10.8.5 Utility Conflicts: When locating proposed lighting, the designer should avoid possible conflicts with above-ground and below-ground utilities.

10.8.6 Pull Boxes: Pull boxes should be located a minimum of 18” from the face of the curb to the center of the pull box.

10.9 Testing

10.9.1 Inspection: Inspection of installed light features will be completed by representatives from MTEMC and the City Codes Department, as required. Installations shall adhere to manufacturer’s requirements as they relate to all aspects of the light feature, foundation and connections.

10.9.2 Approval: Once the street lighting has been installed and operational, approval by the City Engineer will constitute acceptance of the street lighting and the City will then be responsible for the energy costs thereafter. All maintenance is the responsibility of MTEMC. All street lighting within each construction phase shall be complete and operational prior to acceptance of subdivision public improvements.

CHAPTER 11

TRAFFIC SIGNS AND MARKINGS

This chapter describes general traffic signing and striping design requirements for use on streets in the City of Franklin. All design, installation and operation of signing and striping shall be in conformance with this section and the latest revision of the Tennessee MUTCD as adopted by the City.

11.1 – Signing - General

11.1.1 Type and Location of Signs

The City Engineer will make the final determination regarding the type and location of signing controls within the right-of-way. These controls shall include traffic control signs (regulatory and warning), street name signs, delineators, and permanent barricades.

11.1.2 Design, Installation, and Maintenance

Because the City will maintain the permanent traffic control devices on public rights-of-way, all traffic control devices shall be fabricated and installed in accordance with this chapter and the latest revision of the Tennessee MUTCD.

11.1.3 Sight Visibility Standards for Traffic Control Signs

These standards are to provide for tree placement and configuration of City streets such that adequate sight distance is provided for traffic control signs. Typical sign types would be mid-block warnings, speed limit signs and stop signs. The recommended standards recognize that different criteria are needed for different travel speeds.

(1) On streets designated at speed limit 25 MPH, the first tree in front of the sign is to be placed a minimum of forty-five (45) feet before the sign.

(2) On streets designated at speed limit 30 MPH, the first tree in front of the sign is to be placed a minimum of sixty (60) feet before the sign.

(3) For trees exceeding ten (10) feet of canopy vertical clearance from the ground, the first tree in front of the sign is to be placed a minimum of twenty-five (25) feet before the sign.

(4) Where signs are placed at the front end of curb extensions or bulbouts, the above tree placements do not apply.

11.1.4 New Street Signing

Permanent signing, unless otherwise approved by the City Engineer, shall be completely in place before any new street is opened to the public.

11.1.5 Other Standards

These Standards are to be used in conjunction with other applicable City Regulations. The City Engineer may allow the installation of decorative posts and sign frames. In these cases the developer, homeowners association or other responsible entity shall be responsible for the maintenance of these special installations. Decorative traffic supports, whether city-provided or developer-provided should be black or dark green in color.

11.1.6 Sign Posts, Supports, and Mountings

Sign posts and their foundations and sign mountings shall be constructed to hold signs in a proper and permanent position, to resist swaying in the wind or displacement by vandalism.

(1) Sign Post

Only square telescoping posts are allowed in the City. The telescoping post shall be constructed in two sections:

(a) Anchor Post. A 2-1/4-inch 12-gauge galvanized steel square stub section with holes, three (3) feet long, is driven into the ground 30 to 33 inches with 3 to 6 inches remaining above the final grade. The sign post system’s material specification is Telspar 22F12A 03PG (or approved equal), 2-1/4-inch x 3 feet anchor post with holes.

(b) Post Section. A 2-inch square galvanized steel post section with holes is inserted into the stub and bolted. The material specification is Telspar 20F12P-10PG (or approved equal), 2-inch square 12-gauge 10-foot post with holes. Posts shall be installed 6 to 8 inches into the anchor (stub), which has 3 to 6 inches sticking out above the final grade.

(2) Post Bolts
Two 2-1/2-inch long, 3/8-inch hex head bolts are used to attach sign posts to sign anchor (stubs). These bolts shall be separated by one pre-drilled hole space and installed 90 degrees to one another.

(3) Sign Bolts
Signs are mounted to the post with a minimum of two bolts (5/16-inch with nylon and metal washers) or standard rivets (TL3806 EG, drive rivet) with nylon washers placed against the sign face. The bolt or rivet system is used to fasten signs to the Telspar post.

(4) Other Sign Mounts
Traffic signal and school flasher poles, when located appropriately, may be used to hold signs such as warning, parking, and speed limit signs. Signal poles should be checked for potential sign installation during the design process and shown on the sign plan sheets. As regards utility and streetlight poles which are owned by owned utility companies, it is the City’s policy to avoid using their facilities as sign supports.

(5) Breakaway Post System
Posts must be of appropriate length to comply with MUTCD specifications for the location, must conform to **TDOT Specifications**, and must meet the standards as provided in NCHRP 350.

11.1.7 Sign Reflectivity
All traffic control signs must be fabricated with reflective materials. All reflective materials must qualify as High Intensity Grade for all signs except those signs for schools, pedestrians and overhead street name blades. For these signs, Diamond Grade sheeting shall be used. All signs or traffic control devices must have a minimum 7-year materials warranty.

11.1.8 Sign Blanks
Aluminum blanks of .080 gauges are standard, except for signs larger than 36 x 36 inches, which shall be .100 or .125 gauge aluminum.

11.2 Intersection Signing

11.2.1 Street Name Signs

(1) General
All street name signs must conform to these standards. If the intersection has a traffic signal, street name signs will be designated as part of the signal installation. The City Engineer will make the final determination regarding the type and location of these street name signs. Overhead street name blades shall be internally illuminated in accordance with the City Supplemental Specifications for Traffic Signals (see Appendix).

(2) Minor Intersection
Nine-inch plates (9"), up to thirty-six (36) inches long, may be used at all minor intersections.

(3) Major Intersection
Twelve-inch plates shall be used at all major intersections, which include the intersections with Collector and Arterial streets.

(4) Sign Assembly
All 9 and 12-inch plates mounted on posts shall be installed with end bolts on all plates. There shall be two plates for each street, with a minimum of four plates per street sign assembly.

(5) Sign Face

(a) Letter Size. Letter size shall be as called for in the current version of the Tennessee MUTCD. The City may require or allow variations at the discretion of the City Engineer.

(b) Color. Letters and numbers are to be white on a green background face. The colors shall not fade when exposed to an accelerated test of ultraviolet light equivalent to 5 years of outdoor exposure. No silk screened signs are permitted.

(c) Border. There shall be no borders on street name signs.

(6) Street Name. Street name designations should be obtained from the approved plat. Internally illuminated signs are to be installed as directed by the City Engineer.

(7) Change of Name. At the point where a street changes names from one section to the next, the change should be designated on the street name assembly by using directional arrows and may require two additional plates.

(8) No Outlet Signs. On any cul-de-sac, temporary dead-end street, or any other streets with only one access point a "No Outlet" sign is required. The "No Outlet" signs may be placed under the street name signs.

11.2.2 Stop Signs

(1) Location of all stop signs shall be determined by the City Engineer. All three or four-way stops are required to meet warrants in the MUTCD, or City ordinances.

(2) Stop signs will be placed in accordance with the TIA and approved construction plans.

11.2.3 Warning Signs
Intersection warning signs may be required on Arterial or Collector streets in advance of major intersections. An advisory plaque identifying the name of the intersecting side street shall be placed beneath the advance intersection warning sign.

11.3 - Traffic Control Signs

11.3.1 Design and Size

Sign specifications and diagrams are detailed in the latest revision of the FHWA "Standard Highway Signs," latest version. Acceptable sign sizes are listed in the standard column of the table printed with each diagram. Expressway and construction signs shall be a minimum 36 inches.

11.3.2 Mounting

New signs should be mounted on new poles, with existing City poles being used where possible. Streetlight locations should be checked for potential sign installation conflicts during the design process and shown on the signing and striping plan sheets. The use of stainless steel banding of signs is acceptable for concrete and steel poles.

11.3.3 Regulatory

(1) Reflectivity. All regulatory signs, except parking, shall be High Intensity grade reflectivity or greater. This includes the red series and black on white signs.

(2) Sheeting Material. All signs shall be fabricated with sheeting material, including letters. No silk-screened signs will be permitted.

(3) Signs at Signalized Intersections. Regulatory signs installed to support traffic signal operations shall be of the light-emitting diode (LED) type.

(4) Stop Sign. Stop signs shall be a minimum of 30 inches.

(5) Yield Sign. For minor intersections only, a yield sign may be used in lieu of a stop sign, at the discretion of the City Engineer according to MUTCD.

(6) Speed Limit Sign. All Collectors and Arterials should have speed limit signs at approximately 1-mile intervals or after intersections as approved by the City Engineer. All subdivisions shall have a speed limit sign at each entrance.

(7) Parking/No Parking Sign. Designated parking and "no parking" zones shall be signed in accordance with MUTCD. No silk screened signs are permitted.

11.3.4 Warning Signs

(1) Reflectivity Requirements. High intensity sheeting is required except for pedestrian and school crossing signs that require use of Diamond grade sheeting.

(2) "No Outlet" Sign. On dead end streets, cul-de-sacs, and temporary dead end streets, a "No Outlet" sign will be required and mounted with standard mounting system under the street name sign. The sign shall be an MUTCD #W14-2a, 30 x 6-inch minimum size black on yellow warning sign.

(3) “Road Closed” Sign and Barricades.

(a) Temporary Dead End. All temporary dead-end streets shall have a Type III barricade with appropriate advance warning sign(s)**.** A temporary dead-end street is anticipated to be a dead end for less than a year. Type III Barricades shall have a “Road Closed” (R11-2, 48 x 30 inches) sign mounted on both sides of the barricade.

(b) Long-Term Dead End. All dead-end streets anticipated to be a dead end for more than a year must use long-term barricades. The barricade shall consist of a split rail fence with round vertical and horizontal members, pressure treated, with two horizontal rails and a centerline of 10 to 12 feet for vertical members. Delineators shall be installed on the vertical members with a minimum of 2 per member. The “Road Closed” sign shall be mounted directly on the fence.

(4) Crosswalk Signs. Crosswalks shall be signed where adjacent to a school, and on an established school pedestrian route at unsignalized intersections, as approved by the City Engineer. There are usually a minimum of 4 signs per crosswalk. The color and installation shall be completed according to MUTCD. The color shall be fluorescent yellow green. The diamond shaped sign shall have a minimum height and width of 36 inches in rural areas and 30 inches in urban areas.

11.3.5 Guide Signs

(1) Reflectivity Requirements. The guide signs shall have high intensity sheeting.
(2) Bicycle signs for bike lanes shall be provided. See Chapter 3 for specific guidance.

11.4 - Roundabouts

11.4.1 Modern Roundabouts

Signing in advance of the circulating street shall be required. Use “Circular Intersection” (W2-6, 36 x 36 inches) and Roundabout “advisory sign” (W16-12p, 30 x 18 inches). The “Yield” sign (R1-2, 36 x 36 inches) shall be located at each entry to the circulatory street. An “arrow” sign, designating direction of travel in circulatory street, shall be located within the central island. Specifications for traffic control signs shall apply to these signs. Refer to the current FHWA guidelines for additional design information.

11.4.2 Mini Roundabouts

Signing in advance of the circulatory street may be required by the City Engineer. See the current FHWA guidelines for additional design information.

11.5 - Pavement Marking and Striping - General

11.5.1 Type and Location of Striping and Markings

The City Traffic Engineer shall make the final determination in regards to the type and location of pavement striping and marking within the right-of-way during the review of the project signing and striping plans.

11.5.2 Design, Installation, and Maintenance

The City maintains the permanent pavement striping and marking on public rights-of-way after completion of the warranty period. All such devices shall be specified and installed in accordance with these Standards; all designs shall be in accordance with these Standards and the latest revision of the MUTCD and Tennessee supplement.

11.5.3 New Street

Permanent striping and marking, unless otherwise approved by the City Engineer, shall be completely in place before any new street is opened to the public. For streets opened to traffic prior to final surfacing and striping, temporary painted traffic markings shall be installed to permanent standards. New striping on new streets, overlays, and chip seals, etc. will require thermoplastic installations.

11.6 - Pavement Markings (Symbols, Arrows, Word Markings)

11.6.1 General

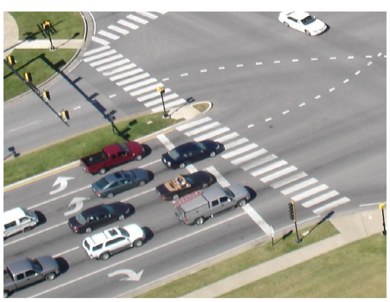
The City may allow preformed thermoplastic on all pavement markings such as arrows, word markings, crosswalks, railroad crossings, school crossings, stop bars, and bike symbols.

11.6.2 Preformed Thermoplastic Specifications

The prefabricated markings described shall be 90 or 125 mils in thickness and consist of white or yellow pigmented plastic film with imbedded reflective glass spheres, uniformly distributed throughout their entire cross-sectional area. It shall be possible to affix the markings to bituminous or Portland cement concrete pavements by either a pressure sensitive precoated adhesive or a liquid contact cement. Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the MUTCD.

11.6.3 Crosswalks

(1) General. Crosswalks shall be used at all signalized intersections, approved crossings, school routes, adjacent to schools, and as otherwise directed.



Typical “Continental” style crosswalk

(2) Mid-block crosswalks shall be approved on a case-by-case basis subject to and engineering study as approved by the City Engineer.

(3) Standard Crosswalk Configuration. White 6-feet minimum width and 24-inch wide “Continental” style bars shall be used for all crosswalks unless otherwise approved by the City Engineer. Where concrete pavement is present, the specific manufacturer’s primer must be applied as per manufacturer’s specifications.

11.6.4 Stop Bars

All stop bars shall be white and a minimum of 24 inches wide. Stop bars shall be used at all signalized locations, selected stop sign locations, and other locations specified by the City Engineer.

11.6.5 Yield Lines

All yield lines shall be white triangles a minimum of 18 inches high. Yield lines shall be used at locations specified by the City Engineer.

11.6.6 Symbols
Preformed thermoplastic pavement marking standard material shall be a minimum of 125 mils thick or approved equal. This material shall be used for all arrows, word markings, bike symbols, bike diamonds, railroad crossing symbols, etc.

11.6.7 Bikeways
The purpose of the placement of bicycle markings on the street is to reinforce the specified use of this designated area (Bike Lane/Bike Routes) and to supplement any regulatory signs. Bicycle markings are to be used on Collector and Arterial streets with designated Bike Lanes. Whenever possible, longer lasting marking materials (i.e., Stamark) should be used. Bicycle markings are to be re-installed in the same location on streets that have been under construction for routine street maintenance or rehabilitation.

11.6.8 Roundabouts

(1) Yield Line. The roundabout shall typically require a dotted yield line at the point of entry into the circulatory street. Installation of white triangles transverse to the entry approach shall be considered optional.

(2) Crosswalk. If used, crosswalks at a roundabout need to be at least 25 feet upstream of the yield line or yield location.

11.7 - Pavement Striping

11.7.1 General

(1) Typical striping widths for lane lines are 4 inches, unless otherwise noted. Double yellow centerline must have a 4-inch minimum gap between stripes according to MUTCD.

(2) Pavement. Epoxy paint shall be used for concrete pavement striping and thermoplastic shall be used for asphalt pavement striping.

(3) Layout. All striping on sealcoats shall require a layout line. Prior to striping, tabs are required for sealcoats (prior to the sealcoat process). All other conditions require spot taping.

11.7.2 Broken Line
All broken lines shall be created with 4-inch wide white paint (min.).

11.7.3 Turn Bay Line
All turn bay lines shall be created with an 8-inch wide dotted line. However, if a turn bay occurs on a horizontal curve, it’s entrance shall also be marked with short 8-inch wide dotted lines (2’ long with 4’ gap).

11.7.4 Centerline
All centerline striping shall be double yellow, each 4 inches wide, with a 4-inch minimum gap between the two.

11.7.5 Parking Stalls
All striping for parking shall be white and 4 inches wide. All edge lines of parking areas shall also be white and a minimum of 4 inches wide.

11.7.6 Bikeways
A 4-inch wide white stripe shall be used for Bike Lanes and edge lines, except where the right edge of a bike lane is also a turn bay lane (8 inches wide).

11.7.7 Lane Line Extensions Through Intersections

These markings extend longitudinal lane lines to indicate turning paths through an intersection, whether single or double turn lanes. These 8 inch wide doted lines are 2 feet long with 4 foot gaps.

11.8 - Temporary Striping

All temporary striping shall conform to "Standard Specifications for Road and Bridge Construction," published by **TDOT**, the latest revision except as herein amended. When approved, temporary striping shall be required prior to the opening of a street for travel where pavement and/or permanent striping cannot be completed due to weather and/or time constraints.

11.8.1 Specifications

Temporary striping shall be the same color and width as for permanent striping. Temporary striping shall consist of temporary striping or thermoplastic (no pavement marking "tabs" or temporary tape is allowed), depending on the pavement surface, spaced at 25-foot intervals.

11.8.2 Time Duration Limit

Temporary striping is permitted on Collectors for no more than 30 days. Temporary striping is permitted on Arterials for no more than 15 days.

11.8.3 Extensions

Extensions must be requested in writing if weather does not allow installation of permanent striping.

11.9 - Specifications

The following specifications shall be used for various types of striping and marking installations in the City.

11.9.1 Extruded Thermoplastic Striping and Markings

Thermoplastic pavement markings should be used on all public and private City street projects. Thermoplastic traffic striping and pavement markings shall conform to Section 716.03 "Thermoplastic Pavement Markings", of the Tennessee Department of Transportation Specifications (TDOT), and to these Specifications. Thermoplastic shall be Alkyd type for extrusion application, and shall produce an adherent reflectorized strip capable of resisting deformation by traffic. The thermoplastic material shall be one hundred percent (100%) solids. The binder shall consist of synthetic alkyd resins, and shall be homogeneously incorporated with all the necessary prime pigments, fillers and glass beads to produce a coating that meets the TDOT specifications.

The thermoplastic material shall be applied in a single, uniform layer by extrusion methods. Stencils shall be used when applying thermoplastic material for pavement markings. Stencils may be new or used if in good condition. If stencils are bent or damaged they shall be replaced. The pavement surface to which thermoplastic material is applied shall be completely coated by the material and the voids of the pavement surface shall be filled. Unless otherwise specified in the Special Provisions, the thermoplastic material for traffic stripes shall be applied at a minimum thickness of .075 inch. Thermoplastic material for pavement markings shall be applied at a thickness of

0.125 inch. Glass beads shall be applied immediately to the surface of the molten thermoplastic material at rate of not less than eight (8) pounds per one hundred (100) square feet. The amount of glass beads applied shall be measured by stabbing the glass beads tank with a calibrated rod.

11.9.2 Painted Striping and Markings

Painted pavement markings may be used on all non-public projects and shall be replaced when visibly worn. Painted traffic stripes and pavement markings shall conform to Section 716.06, “Paint”, of the TDOT Specifications, and to these Specifications. Self-sticking traffic marking tape, vinyl or otherwise, developed for such use shall be used for temporary striping as required, unless otherwise shown or specified in the Contract. The lengths of the gaps and individual stripes that form broken traffic stripes shall not deviate more than two inches (2”) from the lengths required to produce a uniformly repeating, broken-stripe pattern.

11.9.3 Preformed Striping and Markings

Preformed traffic stripes and pavement markings shall be furnished and placed in accordance with TDOT Specifications – Section 716.05 and these Specifications and as directed by the City Engineer. All pavement markings shall be in conformance with the latest edition of the Manual on Uniform Traffic Control Devices. The preformed stripes and pavement markings shall consist of white or yellow film with pigments blended to conform to standard highway marking colors. The pigments shall be thoroughly blended to produce long lasting colors resistant to the effects of weather exposure and to last through the expected life of the film. The preformed tapes shall consist of a pressure sensitive adhesive that is capable of adhering to clean and dry bituminous or portland cement surfaces.

All surfaces shall be prepared and tape applied as indicated by the manufacturer's specifications. The Contractor shall post-inlay all traffic stripes and markings on new asphalt surfaces in accordance with the manufacturer's recommendations and these Specifications. The Contractor shall post-inlay within twenty-four (24) hours of the placement of an asphalt overlay. The Contractor shall provide manual or automatic application equipment as required. The application equipment shall be capable of simultaneously applying two (2) parallel four-inch (4”) lines spaced three-inches (3”) apart. The application equipment shall also be capable of applying unlined, pre-coated, pressure-sensitive, adhesive pavement marking tape. The manual unit shall have a manually actuated product feed advance system and a foot operated product cutting mechanism. The automatic unit shall have the capability of advancing, applying, and cutting the pavement marking tape at specific pre-programmed lengths, at speeds up to six and one half miles per hour (6.5 mph) when towed by an appropriate vehicle. Additional supplemental equipment for manual application of required primers, or for manual tamping of the applied markings shall also be provided. Prior to installation, the Contractor shall submit to the City Engineer for approval the method the Contractor proposes to use to install traffic stripes and markings, including a list of equipment to be used in the installation. The completed traffic stripes and markings shall have clean, well-defined edges, without deformations, and be free of tears or other disfigurements. Improperly placed, defective, or disfigured traffic stripes and markings shall, at the Contractor's expense, be immediately removed from the pavement surface by methods approved by the City Engineer. Completed traffic stripes shall be uniform, straight on tangent alignment, and on a true arc on curved alignment. On tangent alignment, when a one-hundred-foot (100’) string line is stretched taut and placed directly on the outer edge of the completed traffic stripe, the distance between the string and the edge of the traffic stripe shall not exceed three-quarters of an inch (3/4”), measured anywhere along any one hundred-foot (100’) interval of the tangent alignment. On curved alignment, the outer edge of the traffic stripe shall not deviate more than three-quarters of an inch (3/4”) from the true arc. The lengths of the gaps and individual stripes that form broken traffic stripes shall not deviate more than two inches (2”) from the lengths required to produce a uniformly repeating, broken-stripe pattern.

Preformed striping material shall be durable retroreflective preformed pavement tape (#5730) with glass beads as manufactured by the 3M Company or equivalent if approved in writing by the City. The preformed tape shall have the minimum reflective values measured in accordance with ASTM Designation: D 4061:

Twelve-inch (12”) preformed traffic striping (white and yellow) and markings shall be furnished and placed in accordance with these Specifications and as directed by the City Engineer. Preformed traffic stripes shall be installed on all newly resurfaced streets. Preformed striping material shall be durable retroreflective preformed pavement tape (#420) with glass beads as manufactured by the 3M Company or equivalent product as approved by the City Engineer. The preformed tape shall have the minimum reflective values as measured in accordance with ASTM Designation: D 4061.

11.9.4 High Reflective Preformed

Preformed striping material shall be durable retroreflective preformed patterned pavement tape (#380) with ceramic beads as manufactured by the 3M Company or equivalent if approved in writing by the City Engineer. The preformed tape shall have the minimum retroreflective values measured in accordance with ASTM Designation: D 4061.

11.9.5 Placement

New traffic striping of the roadway centerline shall be installed on each segment of roadway construction on the same day that the final lift of asphalt concrete pavement is placed on that roadway segment. New traffic striping of lane lines, crosswalks, and stop bars (skip white and solid white) shall be installed on each segment of roadway construction within one Calendar Day of the final lift of asphalt concrete pavement placed on that roadway segment. If application of lane line striping, crosswalks, and/or stop bars is not completed on the required day, the Contractor shall supply and install temporary pavement markings as detailed below:

Temporary pavement markings shall be flush mounted reflectorized tape squares, four inch by four inch (4” x 4”) 3M “Stamark” with backing liners, detour grade, #6350 yellow and #6351 white, or approved equivalent. Right turn barrier lines, edge lines, and shoulder lane lines shall not be delineated with temporary pavement markings. The Contractor shall remove the temporary pavement markings prior to the installation of new striping. All other required new striping (e.g. bicycle lane stripes, edge lines, pavement markings, etc., not listed above) shall be installed on each roadway segment within two (2) Working Days of the day the final lift of asphalt concrete pavement is placed on that roadway segment.

CHAPTER 12

DRAINAGE DESIGN

12.1 - Overview

As it relates to roadways, the objective of surface drainage is to remove storm water from the traveled roadway as rapidly as possible so that traffic may move safely and efficiently. This is accomplished through careful roadway engineering practices such as using proper cross slopes, longitudinal grades, and cross drainage structures.

In the case of private development design, the planning and design of the overall drainage system should be done simultaneously with the road or street layout and gradient planning and design. Where positive lot drainage is proposed, coordination of the road or street grades and the finished lot elevations must be achieved.

12.2 – Requirements

Other analysis methods may be used as long as supporting calculations are included in the plan submittal.

12.2.1 – Analysis Method

The *Rational Method* is recommended for estimating the design storm runoff for *drainage areas less than 100 acres*. The Rational Method is the preferred method to be used when all of the required data is available. The Rational Method for computing peak storm runoff is expressed as:

$$Q = CiA$$

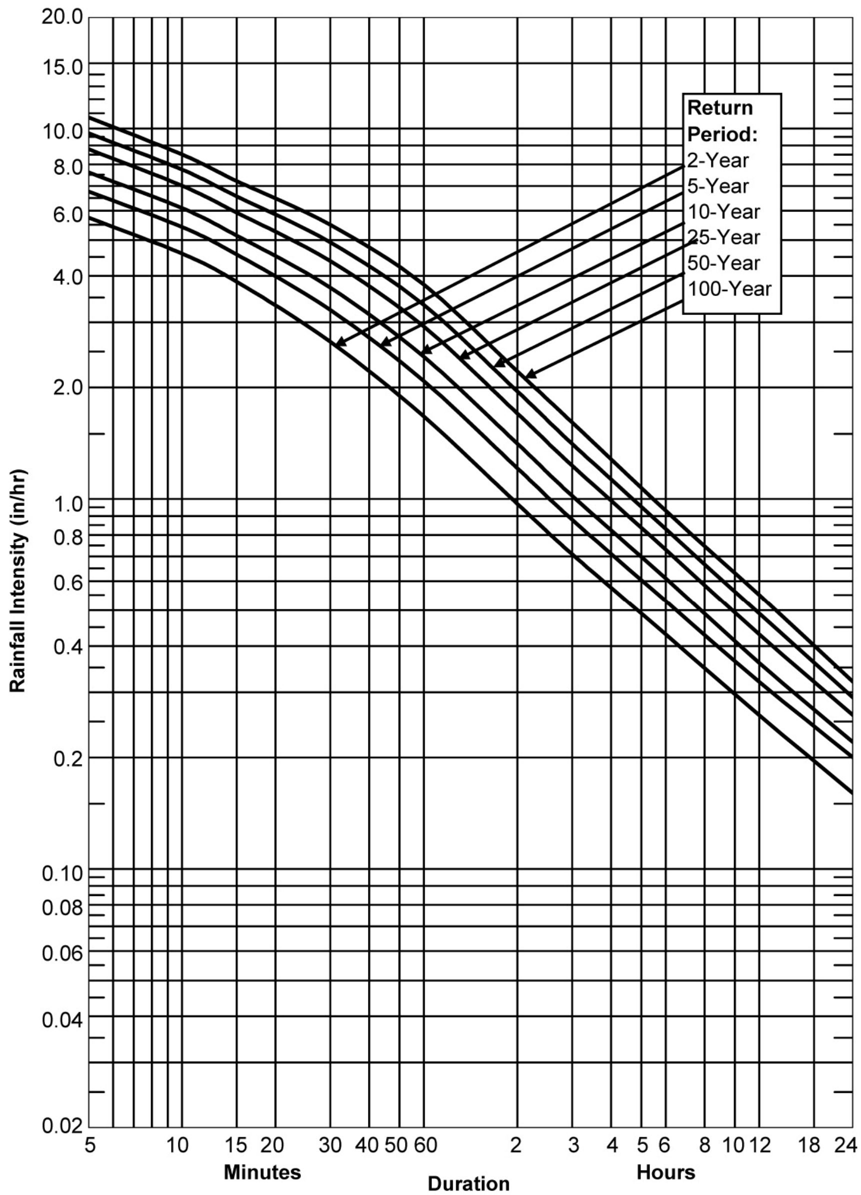
C = weighted runoff coefficient representing a ratio of runoff to rainfall, (unitless) see table below for values

Runoff Coefficients (C) for Use in the Rational Method	
Urban Areas	
Surface Type and Condition [1,2]	Runoff Coefficient (C)
Flat residential, with about 30 percent of area impervious	0.4
Flat residential, with about 60 percent of area impervious	0.55
Moderately steep residential, with about 50 percent of area impervious	0.65
Moderately steep developed area, with about 70 percent of area impervious	0.8
Flat commercial/industrial, with about 90 percent of area impervious	0.8
Rural Areas	
Surface Type and Condition [1,2]	Runoff Coefficient (C)
Concrete or sheet asphalt pavement	0.8 - 0.9
Asphalt macadam pavement	0.6 - 0.8
Gravel roadways or shoulders	0.4 - 0.6
Bare earth	0.2 - 0.9
Steep grassed areas (2H:1V)	0.5 - 0.7
Turf meadows	0.1 - 0.4
Forested areas	0.1 - 0.3
Cultivated fields	0.2 - 0.4

[1] For flat slopes and/or permeable soil, use the lower values. For steep slopes and/or impermeable soil, use the higher values.
[2] For areas where there is a shallow bedrock surface use the higher values.

i = average rainfall intensity for a duration equal to the time of concentration, for a selected return period, (in/hr)

Rainfall intensity (I) is the average rainfall rate (in/hr) for a duration equal to the time of concentration for a selected return period. The NRCS TR55 method shall be used to determine the time of concentration, Tc. Once a particular return period has been selected for design, and the time of concentration calculated for the drainage area, the rainfall intensity can be determined from Rainfall Intensity Duration Frequency (IDF) Curves. The curves below represent the selected gauged Tennessee city located in the IDF zone for the City.



(Shelbyville Gauge)

NOTE: T_c = 5 minutes is a minimum value to use in all cases

Reference: National Weather Service, NOAA Atlas 14, Volume 2 (2004)

A = drainage area tributary to the point under design, (acres)

The drainage area contributing to a point in question can be determined in the field or measured from a topographic map. Data needed to determine the required variables in the rational equation should be noted at the time of the field reconnaissance.

The *Regression Equation* method shall be used for drainage areas that exceed 100 acres.

Rural Regression Equations - The United States Geological Survey (USGS) developed regression equations for rural areas of Tennessee in 2003. The rural regression equation development is described in Water-Resources Investigations Report 03-4176, "Flood-Frequency Prediction Methods for Unregulated Streams of Tennessee, 2000". The study was based on stream flow data gathered from 453 gauging stations located in rural and lightly developed areas of Tennessee and the adjacent states (except Arkansas). Of these, 297 gages were located in Tennessee. All of the gages had a minimum of 10 years of stream flow data. Stream gages where the historical discharge record had been significantly impacted by urbanization, dredging, or other man-made watershed changes were not included in the analysis.

A regional flood frequency analysis was developed with these gages. The USGS identified drainage area as the only consistently significant variable in predicting peak flow for the range of flood frequencies. The only variable in the equation is the contributing drainage area in square miles, represented by CDA. The resulting flow in cubic feet per second can be obtained by using these equations. The following equation is used for Hydrologic Area 3, which includes the City of Franklin:

USGS Rural Regression Equation	
Recurrence Interval (years)	Hydrologic Area 3
2	$280(CDA)^{0.789}$
5	$452(CDA)^{0.769}$
10	$574(CDA)^{0.761}$
25	$733(CDA)^{0.753}$
50	$853(CDA)^{0.748}$
100	$972(CDA)^{0.745}$
500	$1250(CDA)^{0.739}$

- CDA is Contributing Drainage Area in square miles
- Results are in ft^3/s

Urban Regression Equations - The USGS developed regression equations for small urban streams of Tennessee in 1984. The process is described in Water-Resources Investigations Report 84-4182, "Synthesized Flood Frequency for Small Urban Streams in Tennessee". Twenty-two streams were studied statewide in urban areas with populations between 5,000 and 100,000. The drainage areas for these twenty-two sites ranged from 0.21 to 24.3 square miles. The impervious percentage in the watersheds for the study, ranged from 4.7 to 74.0 percent.

The stream flow record for the gages ranged from four to eight years. Due to the short record for the gages, rainfall-runoff models were calibrated for each of the watersheds. Flood magnitudes for selected recurrence intervals were then estimated for each of the watersheds using the calibrated models. These flood magnitudes were then used in a regional regression analysis to develop the regression equations. Three basin characteristics were determined to be significant in the regional regression analysis. These characteristics are drainage area, percent impervious, and the 2-year, 24-hour rainfall. The urban regression equations developed for Williamson County from this analysis are as follows:

USGS Urban Regression Equation
$Q_{2} = 1.76\ (A / 640)^{0.74}\ I_{IMP}^{0.48}\ 3.68^{3.01}$
$Q_{5} = 5.55\ (A / 640)^{0.75}\ I_{IMP}^{0.44}\ 3.68^{2.53}$
$Q_{10} = 11.8\ (A / 640)^{0.75}\ I_{IMP}^{0.43}\ 3.68^{2.12}$
$Q_{25} = 21.9\ (A / 640)^{0.75}\ I_{IMP}^{0.39}\ 3.68^{1.89}$
$Q_{50} = 44.9\ (A / 640)^{0.75}\ I_{IMP}^{0.40}\ 3.68^{1.42}$
$Q_{100} = 77.0\ (A / 640)^{0.75}\ I_{IMP}^{0.40}\ 3.68^{1.10}$

Q_r = estimated discharge for the recurrence interval indicated, (ft^3/s)
A = drainage area of the watershed, (acres)
I_{IMP} = percentage of impervious area in watershed, (%)
3.68 = $P_{2\text{-}24}$ = 2-year, 24-hour rainfall, (inches) for Williamson County

The USGS urban stream regression equations should be applied to all urban drainage areas greater than 100 acres. The impervious area for the watershed should be between 10 and 75 percent of the total watershed area. The stream flow should be unregulated. The peak flow magnitude should not be affected by in-channel storage or overbank detention storage.

12.2.2 – Minimum Standard Design Frequencies

Drainage structures for new construction shall be designed and built to pass the standard design frequencies in the table below.

Minimum Standard Design Frequencies	
100 Year Flood Peak Flow at Structure (cfs)	Recurrence Interval for Design (years)
$Q_{100} \leq 500$	10
500 cfs < Q_{100} < 5000	25 or 50 *
$Q_{100} \geq 5000$	50 or 100 **

* Depends on development density of area as determined by the Project Engineer and approved by the City Engineer

** 25 year design recurrence intervals may be allowed in certain circumstances determined by the City Engineer

12.2.3 – Drainage / Hydrology Calculations

Drainage/Hydrology Calculations are required as part of the Construction Plan submittal per the requirements set forth in Chapter 2 of these specifications. These calculations are *required to be endorsed by a TN registered professional engineer.*

The maximum allowable headwater to depth ratio shall be 1.5

Calculations should include the following as a minimum for submittal:

- Drainage area calculations include area in acres, runoff coefficients, a description of runoff calculation methods used including rainfall intensity, and runoff (Q) used in calculations.
- Culvert cross sections clearly showing invert and outlet elevations, culvert lengths, roadway elevation and lengths.
- Energy Dissipation Design calculations (HY8 dissipator analysis reports will be accepted)
- Computer analysis report output. Preferred computer programs are as follows: HY8 (FHWA Culvert Analysis), Hydroflow Hydrographs, Hydroflow Storm Sewers, HEC-RAS for bridges and large culverts.
- Force effects (including earth pressure, dead load, and vehicular dynamic loading) on buried drainage structures *if requested by the City Engineer..*
- Summary of high water elevations *if open channel flow is present*

12.2.4 – Drainage Structures

This section covers typical buried structures as they relate to drainage which is covered in the AASHTO Bridge Standards Manual.

A -General Guidelines

The design life for buried drainage structures shall be a minimum of 100 years.

Drainage structures shall be designed for force effects resulting from horizontal and vertical earth pressure, pavement load, live load and vehicular dynamic load. Where buried drainage structures with inverts below the water table are used, water buoyancy loads should be taken into consideration as well. References to tables in product design manuals or calculations showing that structures meet loading force requirements should be included in supporting calculations which are to be submitted with construction plans.

B - Pipe Materials and Requirements

Reinforced Concrete Pipe – Buried reinforced concrete pipes shall be designed to resist structural failure due to flexure, thrust, shear, and radial tension. The dimensions of the pipe sections shall be determined with either the direct or indirect method as outlined in the AASHTO Bridge Standards Manual. For standard installations, the live load on the pipe shall be assumed to have a uniform vertical distribution across the top of the pipe and the same distribution across the bottom of the pipe.

Reinforced Concrete Cast-in-Place and Precast Box Culverts – Installations of trenches or embankments due to the installation of this type of drainage structure shall adhere to **Chapter 5, Earthwork**, in these specifications. Distribution of wheel loads and concentrated loads for culverts with less than 2 feet of cover shall be as specified for slab-type superstructures.

High Density Polyethylene (HDPE) – Installations of HDPE pipe shall adhere to the latest American Water Works Association (AWWA) specification as well as the American Society for Testing and Materials Standards (ASTM) D2321 & D2774. Backfill material for HDPE must meet an 85% proctor density per manufacturer’s requirements. The design requirements for HDPE pipe may be relaxed if used in temporary roadway settings or special conditions as approved by the City Engineer.

Corrugated Metal Pipes (CMP) – CMPs will only be allowed as culverts during temporary construction or in the rare occurrence that one is needed to replace an existing CMP under a private driveway.

12.3 – Ditch Sections

Erosion Prevention and Sediment Control is a significant issue during and after construction. The City has a Stormwater Management Ordinance that serves as the City's primary Stormwater guideline. Adherence to these ordinances is required at all times during the construction of ditch sections to ensure that slopes and channels will continue to function adequately.

12.4 – Detention / Retention Basins

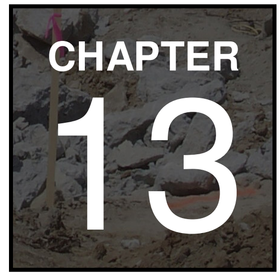
Detention basins are used to collect and hold stormwater runoff for a period of time to compensate for increases in stormwater runoff caused by reduced ground surface perviousness due to activities such as paving or building construction. Retention basins are similar to detention, but they retain a certain portion of the runoff in the basin. Both types of basins must adhere to the current edition of the City's Best Management Practices Section 6, PTP-02 & PTP 03.

12.5 – Best Management Practices (BMPs)

The City has compiled a Best Management Practices Stormwater Management Manual that is designed to assist contractors, developers, and various businesses and industries to comply with the guidelines set forth by the National Pollution Discharge Elimination System (NPDES) Phase II Rule. The BMP Stormwater Management Manual should serve as the major tool to insure that the guidelines set forth in the City's Stormwater Management Ordinance are followed during the design and construction of transportation projects.

12.6 – Inspection and Laboratory Testing

It is the developer's responsibility to perform all materials testing required. The owner's engineer or his representative, familiar with assumptions inherent in the structure design, shall review the construction in sufficient detail to confirm that the construction is as specified. Inspection shall occur as frequently as necessary to assure that the construction conforms to the plans and specifications. Inspection shall be by qualified technical personnel experienced in the inspection of similar structures. Testing of materials shall conform to the requirements of TDOT Standard Specifications and applicable interims.



DEMOLITION AND ABANDONMENT

13.1 - Overview

The following guidelines have been established for permit issuance and inspection of the demolition of transportation features and structures within the City. Work associated with demolition and abandonment will consist of the demolition, removal and satisfactory disposal of items that have been selected for demolition on approved construction plans. Demolition will not be approved until satisfactory arrangements have been made to maintain traffic. Demolition of all items, including those not detailed below, shall be coordinated with the City and/or the Codes Department Director.

13.2 - Historical Research Resources

It is the responsibility of the contractor and designer to identify historic properties and to submit and follow plans that take these into account. Record searches can be performed at the Tennessee Historical Commission (THC), which houses the Tennessee State Historic Preservation Office. THC is located in Nashville and is the central repository for information on architectural surveys for the state of Tennessee. Their records can assist the contractor and designer in determining properties along the project corridor that have been listed in the National Register of Historic Places or if they have been inventoried in past surveys. Any records of historic properties shall be noted on the construction plan as measures taken to avoid such properties.

13.3- Requirements

13.3.1 – Right-of-Way Closure/Abandonment

Once right-of-way has been identified for closure, the City Engineer will make a recommendation to the Board of Mayor and Alderman (BOMA). If approved by BOMA, notification will be sent to adjacent property owners of the action as well as explaining that maintenance of the abandoned right-of-way will be the responsibility of adjacent property owners. A copy of the ordinance will be forwarded to the Williamson County Tax Assessors Office for changing the property lines and the GIS map. Any plat recording of the changed boundaries will remain the responsibility of the respective property owners.

13.3.2 – Removal of Drainage Structures

Where portions of existing drainage structures lie within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Pipe designated to become the property of the City of Franklin shall be carefully removed and every precaution taken to avoid breaking or damaging the pipe.

13.3.3 - Removal of Pavement, Sidewalks, Curbs, Etc.

All pavement, base course, sidewalks, curbs, gutters, driveways, etc. shall be removed and disposed of as follows: If the items are more than two feet below sub-grade elevation, they shall be broken into sizes not to exceed two feet in maximum dimension and remain in place, unless it interferes with succeeding items of construction. If the items are less than two feet below the sub-grade elevation, they shall be removed and disposed of.

Failure of the plans to identify the existing of concrete pavement under asphaltic pavement shall not be construed to imply that concrete is not present. It is the contractor's responsibility to determine the presence of concrete pavement when it is not identified by the plans.

City of Franklin, TN
Department of Engineering

Appendix A

Glossary

Title Sheet

Certificate of Acceptance

Standard Forms

GLOSSARY

AASHTO: American Association of State Highway and Transportation Officials.

ACCESSIBLE PEDESTRIAN SIGNAL (APS): A device that communicates information about pedestrian timing in non-visual format such as audible tones, verbal messages, and/or vibrating surfaces. (MUTCD)

ACCESS EASEMENT: A publicly owned area of land granted by adjacent landowners or reserved as part of a development plan and being part of the City right-of-way for the purpose of accessing public improvements for maintenance.

ACTUATED OPERATION: A type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation. (MUTCD)

ACTUATION INDICATOR: Either a light, a tone, a voice message, or both audible and visual indicators that indicate to pedestrians that the button press has been accepted.

ACTUATION: Initiation of a change in or extension of a traffic signal phase through the operation of any type of detector. (MUTCD)

ALERT TONE AT ONSET OF WALK INTERVAL: A very brief burst of high frequency sound, rapidly decaying to a 500 Hz WALK tone, to alert pedestrians to the exact onset of the walk interval.

APPROACH: The portion of an intersection leg which is used by traffic approaching the intersection

APS: See Accessible pedestrian signal.

ARMY CORPS OF ENGINEERS: Provides engineering services as a government agency as it relates to civil engineering projects.

AUDIBLE BEACON: Use of a sound source to provide directional orientation and alignment information.

AUTOMATIC VOLUME ADJUSTMENT: An APS volume control that is automatically responsive to ambient (background) sound; automatic gain control.

AUXILIARY LANE: The portion of a street adjoining the traveled way for parking, speed change, turning, weaving, truck climbing and other purposes supplementary to through traffic movement.

AVERAGE DAILY TRAFFIC (ADT): The total bi-directional volume of traffic passing through a given point during a given time period (in whole days), divided by the number of days in that time period.

BICYCLE PLAN: Plan initiated by the City to promote multi-modal transportation and to provide safe and accessible facilities for bicycles and pedestrians. Standards address design features of bicycle facilities.

BOMA: Board of Mayor and Alderman

BRAILLE STREET NAME: Provision of the name of the associated street in Braille above the APS pushbutton.

BUTTON ACTUATED TIMER (BAT): See Extended button press.

CAPACITY: The maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform segment of a lane or roadway during a given time period under prevailing traffic, roadway and control conditions.

CITY STANDARDS & SPECIFICATIONS: Those standards prescribed for the construction of streets, sidewalks, driveway access points, curb and gutter set out in this manual and the City Code.

CITY: The City of Franklin, TN

CITY ENGINEER: A licensed professional engineer employed by the City or his duly authorized representative serving to direct and oversee engineering design, coordination and implementation of private and City capital improvements as well as public safety and welfare.

CLEARANCE INTERVAL INDICATOR: Tones sounding during the pedestrian clearance interval that are differentiated from the walk interval indicator (tones).

CODES DIRECTOR: City official responsible for directing the enforcement and interpretations of the provisions of national and local building codes.

COMMERCIAL DRIVEWAY ACCESS: Any driveway access point that does not meet the definition of residential driveway access.

CONNECTIVE STREET: A street within a development, other than a cul-de-sac street or loop street, which will allow vehicular and pedestrian circulation to adjoining developments; thereby providing for community-wide circulation.

CONTROLLER UNIT: That part of a controller assembly that is devoted to the selection and timing of the display of signal indications. (MUTCD)

CORNER CLEARANCE: At an intersecting street, the distance measured from the edge of pavement curb line or the intersection of right-of-way lines to the beginning of outside driveway radius.

CROSSWALK.: (a) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the centerline; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface. (MUTCD)

CYCLE LENGTH: The time required for one complete sequence of signal indications. (MUTCD)

DEAD-END STREET: A local access system street opened at one end only with special provisions for a vehicle to turn around.

DESIGN SPEED: Usually up to five miles per hour above the expected operating speed of the facility under design.

DETECTABLE WARNING: A standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path.

DETECTOR: A sensing device used for determining the presence or passage of vehicles or pedestrians. (MUTCD)

DEVELOPER: A site planner or subdivider.

DEVELOPMENT OR DEVELOPMENT PLAN: Any site plan or subdivision.

DRIVEWAY ACCESS POINT: A point of ingress and egress, or both, which is considered a private driveway. It can be either a residential access point or a commercial driveway access point.

DRIVEWAY WIDTH: The narrowest width of driveway measured parallel with the edge of street.

EXTENDED BUTTON PRESS: On APS, holding the ped button down between 1-3 sec. may activate special features, including audible beaconing and extended pedestrian clearance interval.

FHWA: Federal Highway Administration

FIXED TIME OPERATION: See Pretimed operation.

FLASHING (FLASHING MODE): A mode of operation in which a traffic signal indication is turned on and off repetitively. (MUTCD)

FLOW LINE: The transition point between the gutter and the face of the curb. For a valley curb it is the center of the pan. Where no curb exists, the flow line will be considered the edge of the traveled way.

FULL-ACTUATED OPERATION: A type of traffic control signal operation in which all signal phases function on the basis of actuation. (MUTCD)

GRADING PERMIT: Permit issued by the City of Franklin Engineering Department that allows the contractor to begin grading work.

HBP: Hot bituminous pavement

INTERSECTION: (a) the area embraced within the prolongation or connection of the lateral curb lines, or if none, the lateral boundary lines of the roadways of two highways that join one another at, or approximately at, right angles, or the area within which vehicles traveling on different highways that join at any other angle may come into conflict; (b) the junction of an alley or driveway with a roadway or highway shall not constitute an intersection. (MUTCD)

INTERVAL SEQUENCE: The order of appearance of signal indications during successive intervals of a signal cycle. (MUTCD)

INTERVAL: The part of a signal cycle during which signal indications do not change. (MUTCD)

ITE: Institute of Traffic Engineers

LEVEL OF SERVICE: A measurement of the quality of service on transportation infrastructure. This is generally links to transportation trip time as it relates to speed.

LOCATOR SIGNAL: See Pushbutton locator tone.

LONG BUTTON PRESS: SEE EXTENDED BUTTON PRESS.

LONG CANE: A cane individually prescribed to provide safety and orientation information to persons who are blind or visually impaired; typically much longer than a support cane and not intended for support; typically has a white, reflective surface.

LOOP STREET: A street which is designed to discourage through traffic from other areas and both ends of the loop street connect with the same intersecting street.

MAJOR STREET: The street normally carrying the higher volume of vehicular traffic. (MUTCD)

MAJOR THOROUGHFARE PLAN: Plan in initiated by the City of Franklin Planning Department to address some design features as they relate to thoroughfares.

MEDIAN: That portion of a divided roadway separating the traveled ways for traffic in opposite directions.

MINOR STREET: the street normally carrying the lower volume of vehicular traffic. (MUTCD)

NCHRP: National Cooperative Highway Research Program

PASSIVE PEDESTRIAN DETECTION: A feature that uses sensors (piezo-electric, infrared, microwave, or video camera serving remote sensor software) to trigger, cancel, or lengthen pedestrian timing, or to trigger the pushbutton locator tone when the pedestrian enters the detection zone.

PAVEMENT MARKINGS: All lines, words or symbols, except signs officially placed within the roadway or parking area to regulate, warn or guide traffic.

PCC: Portland cement concrete

PEAK-HOUR VOLUME: Hourly traffic volume used for roadway design and capacity analysis, usually occurring during one or more peak travel hours during a 24 hour period.

PEDESTRIAN CHANGE INTERVAL: An interval during which the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "wait." (MUTCD)

PEDESTRIAN PHASE (OR PED PHASE): The cycle of pedestrian timing consisting of three parts: (1) The walk interval (WALK sign); (2) the pedestrian clearance interval (flashing DON'T WALK); and the pedestrian change interval (steady DON'T WALK).

PEDESTRIAN SIGNAL HEAD: A signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DON'T WALK), that is installed to direct pedestrian traffic at a traffic control signal. (MUTCD).

PEDESTRIAN: People who travel on foot or who use assistive devices, such as wheelchairs, for mobility.

PERMISSIVE MODE.: A mode of traffic control signal operation in which, when a CIRCULAR GREEN signal indication is displayed, left or right turns may be made after yielding to pedestrians and/or oncoming traffic. (MUTCD)

PLANNING COMMISSION: Appointed board of local citizens responsible for decision making related to growth and development within the City.

PREEMPTION CONTROL: The transfer of normal operation of a traffic control signal to a special control mode of operation. (MUTCD)

PRETIMED OPERATION: Type of traffic control signal operation in which none of the signal phases function on the basis of actuation. (MUTCD)

PRIORITY CONTROL: A means by which the assignment of right-of-way is obtained or modified. (MUTCD)

PROTECTED MODE: A mode of traffic control signal operation in which left or right turns may be made when a left or right GREEN ARROW signal indication is displayed. (MUTCD)

PROWAAC: Public Rights of Way Access Advisory Committee of the U.S. Access Board, that includes advocates, engineers, architects, and public works officials.

PUDE: Public utility and drainage easement

PUSHBUTTON LOCATOR TONE: A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing and that enables pedestrians who have visual disabilities to locate the pushbutton. (MUTCD)

PUSHBUTTON MESSAGE: A speech message that provides additional information when the APS pedestrian pushbutton is pushed.

PUSHBUTTON: A button to activate pedestrian timing. (MUTCD)

REMOTE ACTIVATION: A handheld pushbutton device allowing a pedestrian to send a message over a short distance to call the ped phase.

RESIDENTIAL DRIVEWAY ACCESS: A driveway access point serving a single family dwelling, mobile home, detached townhouse, two attached townhouses, duplex, multi-unit supportive housing residence, supportive housing residence which is required to provide no more than two (2) off-street parking spaces, or a driveway serving a nonresidential use if the daily volume of two-way driveway traffic is expected to be less than fifty (50) vehicles.

RIGHT-OF-WAY CENTER LINE: (1) The right-of-way centerline of a two-way street shall be a point equidistant between the inside edges of the innermost through travel lane in each direction of travel. (2) The right-of-way centerline of a one-way street shall be a point equidistant between the outside edges of the outermost through travel lanes in the direction of travel. (3) Where the alignment of an existing street is to be altered or changed, the right-of-way centerline shall be determined in accordance with the new realignment plan, provided the City and/or TDOT have approved the plan. (4) In special cases where non-symmetrical street widening has occurred or other unique situations not covered by the above exist, the right-of-way centerline shall be defined by the Transportation Director.

RIGHT-OF-WAY, (ROW) : An interest in land to the City which provides for the perpetual right and privilege of the City and it's agents, franchise holders, successors, and assigns to construct, install, improve, repair, maintain, and use a public street, including related and customary uses of street rights-of-way such as sidewalk, bike path, landscaping, traffic control devices and signage, sanitary sewer, stormwater drainage devices, water supply, cable television, electric power, gas, and telephone transmission and related purposes in, upon, over, below, and across the right-of-way. The City is authorized to remove, and keep removed from the rights-of-way all trees, vegetation, and other obstructions as is determined to be necessary by the City to maintain, repair, and protect facilities located in the right-of-way

ROADWAY: See definition of street.

SEMIACTUATED OPERATION: A type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation. (MUTCD)

SIDEWALK: Any public or private pedestrian or bicycle walkway or path.

SIGNAL HEAD. An assembly of one or more signal faces together with the associated signal housings. (MUTCD)

SIGNAL INDICATION: The illumination of a signal lens or equivalent device. (MUTCD)

SIGNAL PHASE: The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD)

SIGNAL SECTION: The assembly of a signal housing, signal lens, and light source with necessary components to be used for providing one signal indication. (MUTCD)

SIGNAL TIMING: The amount of time allocated for the display of a signal indication. (MUTCD)

SIGNAL WARRANT: A threshold condition that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control signal or other Improvement is justified. (MUTCD)

SLOPE EASEMENT: An easement, which is reasonably necessary and incidental to the construction within the adjoining right-of-way of public street or sidewalk, or both, by the City, state, or their contractors. The purposes to which the easement area may be used include cutting, sloping, filling, installation of stormwater drain pipes or other drainage facilities, grading or otherwise changing the natural contour of the easement area in order to support and to accommodate the development of the adjacent street right-of-way, in accord with generally accepted engineering practices. Following the construction of the adjacent street or sidewalk, or both, the area subject to this easement will be graded, stabilized, and restored using conventional engineering and landscaping methods. Thereafter, the landowners with the underlying fee interest may make and enjoy all lawful uses of the property subject to this easement, provided there be no damage to the lateral and subjacent support of the public street, sidewalk, or h or to any stormwater drainage facility.

STATE ROUTE: An arterial highway designated and signed with a route number, which is primarily funded for construction and administered by TDOT. Improvements and maintenance of state routes is under the jurisdiction of TDOT.

STEADY (STEADY MODE): The continuous illumination of a signal indication for the duration of an interval, signal phase, or consecutive signal phases. (MUTCD)

STORMWATER ORDINANCE: Document initiated by the City of Franklin to establish guidelines for dealing with stormwater.

STORMWATER PERMIT: If approaches to handling stormwater are not standard or specified in the stormwater ordinance, a stormwater permit may need to be applied for by the contractor.

STREET BLOCK FACE: The physical characteristics of property and structures adjoining any one side of a street in-between intersections.

STREET SCAPE: Aesthetic additions (trees, decorative lighting) that are placed outside of the traveled way to enhance appearance.

STREET: A public or private roadway, but is not considered a driveway access point.

STREET DEPARTMENT DIRECTOR: City official responsible for directing and overseeing construction, maintenance, traffic control and stormwater implementation for improvements of City streets.

SUBDIVISION REGULATIONS: Documents initiated by the City of Franklin to establish guidelines for subdivision plans.

TACTILE ARROW (ALIGNED IN DIRECTION OF TRAVEL): A raised (tactile) arrow in an APS pushbutton that helps users know which crosswalk is actuated by the pushbutton.

TACTILE MAP: A raised schematic map (located on an APS pushbutton housing) that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button.

TACTILE: An object that can be perceived using the sense of touch.

TDEC: Tennessee Department of Environment and Conservation

TDOT: The Tennessee Department of Transportation

THROUGH STREET: A street, other than a dead-end street or loop street, that connects two perimeter property lines of a development.

TIA: Traffic impact analysis

TN DIVISION OF WATER POLLUTION CONTROL: A regulatory board that monitors pollution.

TRAFFIC CONTROL SIGNAL (TRAFFIC SIGNAL): Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. (MUTCD)

TRAFFIC SIGN: A device mounted on a fixed or movable support, conveying a message or symbol to regulate, warn or guide traffic.

TRANSPORTATION ADVISORY COMMITTEE: Committee that reviews transportation related items and makes recommendations to BOMA.

TREE REMOVAL PERMIT: Permit issued by the City of Franklin Codes Department that allows the contractor to clear designated trees.

VIBROTACTILE PEDESTRIAN DEVICE: A device that communicates, by touch, information about pedestrian timing using a vibrating surface. (MUTCD)

VOLUME: The number of vehicles passing a given point during a specified period of time.

WALK INTERVAL: An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign." (MUTCD)

ZONING ORDINANCE: Document that regulates land use for the City of Franklin.

Index Of Sheets

CITY OF FRANKLIN	YEAR	SHEET NO.
	2007	1

CITY OF FRANKLIN TENNESSEE Established 1799 HISTORIC

CITY OF FRANKLIN, TENNESSEE

PROJECT TITLE

PROJECT LIMITS

TYPE OF WORK

SITE MAP

BEGIN PROJECT
STA.

END PROJECT
STA.

SCALE: 1"= ________________

PROJECT LENGTH

DESIGNER LOGO

DESIGNER STAMP

TRAFFIC DATA

SPECIAL NOTES

PROPOSALS MAY BE REJECTED BY THE CITY OF FRANKLIN IF ANY OF THE UNIT PRICES CONTAINED THEREIN ARE OBVIOUSLY UNBALANCED, EITHER EXCESSIVE OR BELOW THE REASONABLE COST ANALYSIS VALUE.

THIS PROJECT TO BE CONSTRUCTED UNDER THE STANDARD SPECIFICATIONS OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION DATED MARCH 1, 1995 AND ADDITIONAL SPECIFICATIONS AND SPECIAL PROVISIONS CONTAINED IN THE PLANS AND IN THE PROPOSAL CONTRACT

CITY OF FRANKLIN ENGINEERING DEPARTMENT ERIC J. GARDNER, P.E.
ASSISTANT CITY ENGINEER

DESIGNED BY CONSULTANT NAME

DESIGNER DESIGNER NAME

APPROVED:

DAVID PARKER, P.E. DATE
CITY OF FRANKLIN PUBLIC WORKS DIRECTOR

CITY OF FRANKLIN
PUBLIC WORKS DEPARTMENT
ACCEPTANCE OF FACILITIES

The following streets and drainage facilities have been accepted as part of the public system of the City of Franklin, TN.

____

Development Name (including Section, Phase, Lot Numbers) City of Franklin Project #

Final inspection was conducted by City of Franklin, TN personnel and facilities were found to be in accordance with the approved drawings and specifications or approved modifications thereto. As-Built Drawings (Hard Copies and Digital) were submitted and approved for the facilities.

Final Inspection Date:____________________________ City of Franklin Inspector:________________________________

As-Built Submittal Date:__________________________ As-Built Approval Date:__________________________________

Description of Facilities:

FACILITY	SIZE/WIDTH	LENGTH	UNIT PRICE	VALUE
STREETS:	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
CURB & GUTTER	______	______	______	$______
	______	______	______	$______
SIGNS	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
			TOTAL STREETS	**$**______
SIDEWALKS:	______	______	______	$______
	______	______	______	$______
			TOTAL SIDEWALKS	**$**______
DRAINAGE:	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
HEADWALLS/ENDWALLS	______	______	______	$______
	______	______	______	$______
INLETS/STRUCTURES	______	______	______	$______
	______	______	______	$______
	______	______	______	$______
			TOTAL DRAINAGE	**$**______
TRAFFIC/ITS:	______	______	______	$______
	______	______	______	$______
			TOTAL TRAFFIC/ITS	**$**______

_________________________________ _________________________

David Parker, ACA Public Works Director Date

HISTORIC

CITY OF FRANKLIN
Engineering
Department

Transmittal Letter

Date:_____________

Applicant Information:

Contact Name:		Company Name:	
Address:			
	City:	State:	Zip:

Phone:		Fax:		E-mail:

Project Information:

Project Name:____
Section/Phase:_______________________________Lot #_____________________
City of Franklin Project #:_______________ First Submittal ☐ Resubmittal ☐

Reviewer: (If Resubmittal)

David Parker ☐ Eric Gardner ☐ Tom Ingram ☐

Jonathan Marston ☐ Carl Baughman ☐ Crystal Bishop ☐

Bethany Taylor ☐ Other ________________________________

What type of plans are you submitting? Number of sets____________

Grading and/or Drainage ☐
Critical Lot Plan ☐
Roadway Plan ☐
Final Plat **Digital File (Y/N)** ☐
Drainage Calculations ☐
Stormwater Permit Fee ☐
Water and/or Sewer ☐
Traffic Study ☐
Preliminary Plat ☐
Concept Plan ☐
Stormwater Permit Application ☐
Long Term Maintenance Plan ☐
Stormwater Pollution Prevention Plan (SWPPP) ☐
Other____

Comments____

____

____

____

____

BOND CALCULATIONS

City of Franklin Engineering Department

DEVELOPMENT:____

____ BY: ________________

NO. LOTS / UNITS:_______________SFUE's= __________ DATE: ________________

SURETY DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
I. WATER: *(No bond if MVUD or other district's water)*				
4" MAIN *(4" not included in inspection fees)*	________	LF	$30	$__________
6" MAIN	________	LF	$35	$__________
8" MAIN	________	LF	$40	$__________
10" MAIN	________	LF	$45	$__________
12" MAIN	________	LF	$50	$__________
16" MAIN	________	LF	$55	$__________
FIRE HYDRANT	________	EA	$1,700	$__________
			TOTAL WATER =	**$**__________
			(Min. $10,000)	
			1.10 X Total	**$**__________
			ROUNDED	**$**__________
TOTAL LF WATER *(For inspection fee cost)*	________	LF		
II. SEWER:				
8" MAIN	________	LF	$45	$__________
10" MAIN	________	LF	$50	$__________
12" MAIN	________	LF	$55	$__________
15" MAIN	________	LF	$60	$__________
18" MAIN	________	LF	$65	$__________
4' DIAMETER MANHOLES	________	EA	$2,000	$__________
FORCE MAINS *(Use water main pricing)*	________	LF	SIZE____ $_______	$__________
PUMP STATIONS	________	GPM	*$40*	$__________
			TOTAL SEWER =	**$**__________
			(Min. $10,000)	
			1.10 X Total	**$**__________
			ROUNDED	**$**__________
TOTAL LF Sewer *(For inspection fee cost)*	________	LF		
V. STREETS: *(Includes private streets)*				
12' WIDE PVMN'T	________	LF	$45	$__________
16' WIDE PVMN'T	________	LF	$55	$__________
20' WIDE PVMN'T	________	LF	$65	$__________
24' WIDE PVMN'T	________	LF	$75	$__________
30' WIDE PVMN'T	________	LF	$95	$__________
36' WIDE PVMN'T	________	LF	$115	$__________
38' WIDE PVMN'T	________	LF	$120	$__________
48' WIDE PVMN'T	________	LF	$155	$__________
64' WIDE PVMN'T	________	LF	$205	$__________
TOTAL LENGTH STREETS =	________	LF	*(For curb & sidewalk bond)*	
EXTRUDED CONCTETE CURB	________	LF	$10	$__________
MONOLITHIC CURB & GUTTER	________	LF	$20	$__________
TEMP TURNAROUNDS	________	EA	$20,000	$__________
		TOTAL	**STREETS**	**$**__________
			(Min. $10,000)	
TRAFFIC / STREET SIGNS, ETC. *(15% of Total)*	________	LS	1.15 x TOTAL	$__________
			ROUNDED	**$**__________

BOND CALCULATIONS

City of Franklin Engineering Department

SURETY DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
VI. STREET ACCESS BOND *(Separate Bond)*	___________	EA	$6,000	$_____________
……………………………………………….	…………….	……….	……………………..	…………………
VII. SIDEWALKS: *(5'Wide - Separate Bond)*	___________	LF	$10	$_____________
(Sidewalks are not bonded on commercial plats.			**ROUNDED**	**$**_____________
They are bonded separately with each site plan.)				
……………………………………………….	…………….	……….	……………………..	…………………
VIII. DRAINAGE:				
BIORETENTION	___________	SF	$5	$_____________
DETENTION	___________	CY	$16	$_____________
CULVERTS (15", 18" & 21")	___________	LF	$45	$_____________
CULVERTS (24" & 30")	___________	LF	$55	$_____________
CULVERTS (36" & 42")	___________	LF	$80	$_____________
CULVERTS (48" & 54")	___________	LF	$100	$_____________
CULVERTS (60")	___________	LF	$110	$_____________
CULVERTS (72")	___________	LF	$125	$_____________
BOX CULVERT/S ___ @ ___' X ___'	___________	LF	$_____ *(Est.)*	$_____________
HEADWALLS, ETC.				
15", 18", 21" & 24"	___________	EA	$1,200	$_____________
30" & 36"	___________	EA	$1,400	$_____________
42" & 48"	___________	EA	$1,700	$_____________
54", 60" & 72"	___________	EA	$2,500	$_____________
SINGLE INLET/JUNCTION BOX	___________	EA	$1,400	$_____________
DOUBLE INLET	___________	EA	$2,100	$_____________
SAFETY GRATES	___________	EA	$1,200	$_____________
DITCH WORK	___________	LF	$15	$_____________
		TOTAL	**DRAINAGE**	**$**_____________
			(Min. $10,000)	
EROSION/SILTATION CONTROL *(15% of Total)*	___________	LS	1.15 x Total Drainage	$_____________
			ROUNDED	**$**_____________
……………………………………………….	…………….	……….	……………………..	…………………
IX: ITS ELEMENTS				
3" CONDUIT UNDER SIDEWALK	___________	LF	$25	$_____________
3" CONDUIT UNDER PAVEMENT	___________	LF	$100	$_____________
3" CONDUIT IN NON-PAVED AREA	___________	LF	$15	$_____________
FIBEROPTIC PULL BOX (300-400' APART)	___________	EACH	$700	$_____________
36-STRAND SM FIBER OPTIC CABLE	___________	LF	$6	$_____________
CCTV CAMERA, POLE AND CABINET	___________	EACH	$55,000	$_____________
DYNAMIC MESSAGE SIGN (LARGE)	___________	EACH	$80,000	$_____________
DYNAMIC MESSAGE SIGN (REGULAR)	___________	EACH	$60,000	$_____________
WEATHER MONITORING STATION	___________	EACH	$30,000	$_____________
SIGNAL SYSTEM DETECTORS (2-WAY)	___________	EACH	$7,000	$_____________
SIGNAL CONTROLLER W/ F.O. MODEM	___________	EACH	$5,000	$_____________
Above elements per MTPU Amendment approved 1/26/06.		**TOTAL**	**ITS ELEMENTS**	**$**_____________
CONTINGENCY *(10% of Total)*	___________	LS	1.10 x Total ITS	$_____________
			ROUNDED	**$**_____________

UPDATED: January 31, 2007 CBB

COMMENTS:

INFRASTRUCTURE FEE WORKSHEET

DEVELOPMENT:______________________________

______________________________ BY:______________________

NO. LOTS / UNITS:__________SFUE's=_______ DATE:____________________

FEE DESCRIPTION	**QUANTITY**	**UNIT**	**UNIT COST**	**TOTAL**
(No fee if other district's water)				
STORMWATER PERMIT FEE	________	EA	$100	$__________
GRADING PERMIT FEE	________	EA	$100	$__________
ROAD BORING PERMIT FEE	________	EA	$100	$__________
ROAD CUTTING PERMIT FEE	________	EA	$100	$__________
TREE CUTTING PERMIT FEE	________	EA	$100	$__________
ROADWAY PLANS REVIEW	________	EA	$300	$__________
GRADING & DRAINAGE PLANS REVIEW	________	EA	$300	$__________
WATER PLANS REVIEW	________	EA	$300	$__________
SEWER PLANS REVIEW	________	EA	$300	$__________
ROADWAY INSPECTION	________	LF	$2 *(Min. $1000)*	$__________
DRAINAGE INSPECTION - Storm Pipe	________	LF	$1	$__________
DRAINAGE INSPECTION - Detention Pond	________	100 CY	$1	$__________
DRAINAGE INSPECTION - Ditchwork	________	LF	$1	$__________
TOTAL DRAINAGE INSPECTION			*(Min. $1000)*	$__________
WATER LINE INSPECTION	________	LF	$1.25 *(Min. $1000)*	$__________
SEWER LINE INSPECTION	________	LF	$2 *(Min. $1000)*	$__________
RETEST *	________	TEST	$100	$__________
WATER ACCESS FEE	________	Meter Size	**	$__________
SEWER ACCESS FEE	________	Meter Size	**	$__________
WATER SYSTEM DEVELOPMENT FEE	________	Meter Size	**	$__________
SEWER SYSTEM DEVELOPMENT FEE	________	Meter Size	**	$__________
EFFLUENT DISPOSAL FEE	________	Meter Size	**	$__________
WATER INSTALL. FEE (W/O TAP)	________	Meter Size	**	$__________
WATER INSTALL. FEE (W/TAP)	________	Meter Size	**	$__________
SEWER INSTALL FEE (W/O TAP)	________	Meter Size	**	$__________
SEWER INSTALL FEE (W/TAP)	________	Meter Size	**	$__________
IRRIGATION METER FEE	________	Meter Size	**	$__________
PUMP STATIONS	________	GPM	$5	$__________
FORCE MAIN INSPECTION	________	LF	$1.50 *(Min. $1000)*	$__________

*** Any inspection that had a failed test and requires reinspection(s) and/or testing.**

**** See chart below for complete list of fees based upon meter size.**

	WATER					**SEWER**				
			Installation of meter & box					**Installation Fee**		
Meter Size	**SDF System Development Fee**	**Access Fee**	**Tap Already Made**	**Tap Not Made**	**Irrigation Meter**	**SDF System Development Fee**	**Access Fee**	**Tap Already Made**	**Tap Not Made**	**Effluent Disposal Fee**
3/4"	$860	$1,130	$300	$720	$3,000	$1,375	$2,000	$250	$1,180	$450
1"	$3,440	$4,520	$356	$854	$4,500	$5,500	$8,000	$250	$1,180	$1,800
1 1/2"	$8,256	$10,848	$625	$1,375	$6,000	$13,200	$19,200	$250	$1,180	$4,320
2"	$11,008	$14,464	$1,297	$2,117	$7,500	$17,600	$25,600	$250	$1,180	$5,760
3"	$24,080	$31,640	$1,506	$3,480	$9,000	$38,500	$56,000	$250	$1,180	$12,600
4"	$34,400	$45,200	$2,541	$5,230	$10,500	$55,000	$80,000	$250	$1,180	$18,000
6"	$82,560	$108,480	$4,498	$7,035	$12,000	$132,000	$192,000	$250	$1,180	$43,200
8"	$103,200	$135,600	$9,803	$13,438	$13,500	$165,000	$240,000	$250	$1,180	$54,000

GRADING & EROSION CONTROL PERMIT

CITY OF FRANKLIN

Permit No.

Firm/Contractor Name			Property Address	
Address			Subdivision/Section	Lot No.
City	State	Zip	Tax Map Number	Parcel
Date to Commence Grading			Date of approved Drawings	
Certified Inspector(s) (as of January 1, 2003)	Phone Numbers		Name and date of last Certification Class	

The City of Franklin, Tennessee, hereby grants permission to commence with grading work. Grading work must commence within **30 days** of issuance or grading permit will be void

* Applicant must have an approved ***Stormwater Management Plan*** for this site *before grading work can commence*.

* *Notice of Work*: The contractor shall provide the City of Franklin, Street Department (615) 791-3254 with a **24 hour** notice prior to any grading work. Grading shall conform to lines and grades as shown on the approved drawing and shall be in accordance with the specifications as approved by the City of Franklin, its ***Stormwater Management Ordinance 2001 - 53*****, approved April 9, 2002 and Best Management Practice Manual**.

* Where applicable, work shall also conform to the requirements as for construction done near or in a stream potentially effected by the project set forth in the Aquatic Resource Alteration Permit (ARAP) as issued by the Natural Resource Section of the Tennessee Department of Environment and Conservation on ___________ and the Department of Army permit issued by the Corp of Engineers on ____________for work in or near delineated wetlands. No work shall commence within a TVA easement until TVA has granted permission and written verification is provided to the City of Franklin. The contractor and/or developer shall be responsible for obtaining all permits required by agencies and/or governmental entries having jurisdiction.

* Erosions control devices, as shown on the approved Erosion Prevention Siltation Control Plan, EP&SC, (**enclose map with this Grading & Erosion Control Permit) shall be in place prior to any grading, clearing and/or any other construction activity**. These devices shall be maintained throughout the construction period; generally considered to be through the completion of restoration. **A copy of your EP&SC plan along with an inspection checklist and Stormwater Permit must be at the project site at all times**. The inspection checklist shall have a record of dates EP&SC devices are inspected and any correction action taken or major observations.

* All EP&SC devices are to remain in place until the site has been stabilized and a good stand of grass has been established.

*** Erosion prevention and sediment controls must be inspected before a rain event, weekly and 24 hours after a .25 inch rain event and documented in the inspection site checklist.**

* The project is subject to inspection by the City of Franklin at any time and items found deficient shall be immediately corrected. The City may stop construction on properties, or administer other enforcement actions as defined in Section 8 of the City of Franklin's *Stormwater Management Ordinance*, *2001 – 53* for example*:* does not have adequate erosion prevention and sedimentation control measures or are not maintained properly.

Pre-Construction Check off list:
Please initial that these have been accomplished before construction:

_____ Erosion Prevention and Siltation Control Plan Map accompanying this permit.

_____Silt fence or other sediment barriers, has been installed properly along topographical contours downslope of the area to be disturbed prior to any grading, clearing and/or any other construction activity. Excavated topsoil to be reused must be stockpiled and encircled with silt fencing.

_____This site shall contain a temporary stone construction entrance that conforms to the City of Franklin's Stormwater Ordinance and Best Management Practice Manual within 24 hours of grading commencement or the permit will be revoked. The stone shall be 2 –3 inch in diameter and shall be kept clean by adding stone as needed. It shall be at least 6 inches deep underlain with filter fabric and 20 feet wide.

_____Where applicable, inlet protections for nearby storm sewer curb and drop inlets have been installed.

_____Where applicable, existing vegetation and **Buffer** will be maintained and temporary cover crops will be used.

- ☐ Vegetative buffers or other protection must be provided along streams, rivers, and ponds to avoid erosion of banks.
- ☐ Stabilization measures must be performed within seven (7) days in portions of the site where construction activities have temporarily or permanently ceased, and within fifteen (15) days after final grading.
- ☐ All trees designated to remain, must be protected. Heavy equipment should not be operated or stored, nor materials handled or stored, within the driplines of trees.
- ☐ Sediment must be removed from sediment barriers, ponds and other sediment controls when design capacity had been reduced by 33%.
- ☐ Sediment that has escaped the construction site and has collected in the street or drainage structures must immediately be physically removed.
- ☐ Building and waste materials, and non-storm water discharges, such as concrete, paint washwater, or machinery leakage or spillage must be managed to prevent them from entering the stormwater system, ground water or nearby water body.
- ☐ BMPs must be inspected by a qualified person who has taken an approved erosion and sedimentation course: (Certification required by January 01, 2003).

(Issuance of this Grading & Erosion Control Permit does **not** exempt you from complying with any provision of the city of Franklin's *Stormwater Management Ordinance 2001 – 53* that applies or obtaining a *Stormwater Management Permit*).

(All correspondence is required to reference Permit number)

I certify, under penalty of law, that I have reviewed this document and understand the erosion prevention and sediment control requirements here in. I agree to implement and follow the provisions of the Grading & Erosion Control Permit for the construction site. I understand that these requirements will be inspected and enforced by the City of Franklin and failure to comply may result in the issuance of a *"stop work order"* and/or other penalties until compliance is accomplished. The undersigned will be responsible for complying with this permit and any provision of the Franklin Stormwater Management Ordinance 2001-53 that applies.

Print Name	Signature	Date
Print Name	Signature	Date

Permit Issued by:______________________________ Date: ____________
(Signature)

____
(Title)

dlg/07/16/02

City of Franklin Engineering
City Hall Mall
109 3rd Avenue South
P.O. Box 305
Franklin, TN 37065
Ph. 615.791-3218
Fax 615-791-3293

Stormwater Management Permit Application--SWMP
CITY OF FRANKLIN

Firm/Contractor Name			Property Address		Permit No.
Address			Subdivision/Section	Lot No.	
City	State	Zip	Tax Map Number	Parcel	
Date to Commence Grading			Date of approved Drawings		

☐ $100 Permit fee has been paid.

☐ An approved map and associated construction drawings have been included clearly showing existing site features and proposed alterations highlighting the location and type of proposed **stormwater management system**.

☐ In a separate document: include: 1) Detailed **narrative explanation** of **structural** and **non-structural management practices** chosen for storm water **quality and quantity** and **why** they were used. 2) Explain how 90% of TSS is to be removed of first flush or .5 inches. 3) Include storage, transport, disposal and uses of substances on-site such as propellants, oil and grease, construction debris, fertilizer, concrete truck washout and other chemicals that are potential pollutants. 4) Highlight how this site drainage and runoff affects the entire watershed, (with reference to a Watershed Management Plan, if applicable).

☐ A copy of this **Stormwater Management Plan, narrative description and map,** will be kept on-site at all times for review.

☐ A **long-term maintenance plan** is included and will be kept on-site at all times for review.

(Issuance of this **Stormwater Management Permit** does not exempt you from complying with any provision of the city of Franklin's ***Stormwater Management Ordinance 2001 – 53, Grading and Erosion Control Permit or any other state, federal or local requirements*****).**

(All correspondence is required to reference Permit number)

The application is hereby made for a permit for the activity or activities described herein. I am familiar with the information contained in this application and it is true complete and accurate to the best of my knowledge. I understand that these requirements will be inspected and enforced by the City of Franklin and failure to comply may result in the issuance of a "stop work order" and/or other penalties until compliance is accomplished. A signed copy of this document will be kept on-site with the Stormwater Management System plan map, Grading and Erosion Control Permit, Long-Term Maintenance plan and Inspection Checklist at all times.

Print Name and Title	Signature	Date	Permit No.

Permit Issued by:

By:______________________________ Date: ________________

(Signature)

____

(Title)

City of Franklin Engineering
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dlg/7/02/02

City of Franklin, TN
Department of Engineering

Appendix B

Supplemental Specifications for Traffic Signals

CITY OF FRANKLIN, TENNESSEE
ENGINEERING DEPARTMENT

SUPPLEMENTAL SPECIFICATIONS TO:

THE TENNESSEE DEPARTMENT OF TRANSPORTATION SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION; MARCH 1, 1995 as amended

SECTION 730
GENERAL REQUIREMENTS

730.01 – Description of Work.

All construction, materials, equipment, workmanship and installation procedures shall comply with the T.D.O.T. Standard Specifications for Road and Bridge Construction, March 1, 1995 (as amended) Section 730.01 et al, and with the current standards and specifications of the City of Franklin.

730.02 – Regulations and Code.

In addition to the T.D.O.T. Standard Section 730.02 et al, the contractor shall comply with all City of Franklin codes, permitting process and any requirements established by local utility agencies.

730.03 – Submittal Data Requirements.

In addition to the T.D.O.T. Standard Section 730.03 et al, the contractor shall supply prior to issuance of the "Notice to Proceed" a work schedule and traffic control plan for the City Engineer's review and approval.

730.04 – Mill Reports and Certifications.

730.05 – Working Drawings.

730.06 – Guarantee.

In addition to the T.D.O.T. Standard Section 730.06 et al, the contractor shall follow all applicable City of Franklin ordinances regarding ownership, operation and maintenance of the project installation.

730.07 – Training.

MATERIALS & INSTALLATION

730.08 – Excavating and Backfilling.

In addition to the T.D.O.T. Standard Section 730.08 et al, the contractor shall notify the Tennessee One Call System, Inc. at 1 (800) 351-1111 and each individual utility owner of his plan of operation in the area of the utilities. Prior to commencing work, the contractor shall contact all utility owners and request them to properly locate their respective utility on the ground. This notification shall be given at minimum three (3) days prior to the commencement of operations around the utility.

All utility locations are approximate. It shall be the responsibility of the contractor to verify the location of all utilities prior to construction.

The contractor shall also perform trenching activities in accordance with the City of Franklin's Standard Detail 29 "Trench Details and Conduit Placement".

730.09 – Removing and Replacing Improvements.

In addition to the T.D.O.T. Standard Section 730.09 et al, the contractor shall coordinate with the City of Franklin for removal of the existing traffic control facilities upon activation of the new signal system.

730.10 – Foundations.

In addition to the T.D.O.T. Standard Section 730.10 et al, the contractor shall construct the controller cabinet foundation in accordance with T.D.O.T. standard drawings T-SG-5 and T-SG-6. A Type IV foundation shall be installed.

The contractor shall install an additional level, concrete pad as indicated on the T-SG-6 "Sidewalk Section" drawing.

730.11 – Anchor Bolts.

730.12 – Pull Boxes and Manholes.

In addition to the T.D.O.T. Standard Section 730.12 et al, the contractor shall supply pull box covers as indicated with either the words "TRAFFIC SIGNALS" or "FIBER OPTIC" inscribed to the same specifications as directed by T.D.O.T. Standard Section 730.12.

The City of Franklin will specify the use of a manhole for use with a fiber optic communications system under certain applications. The manhole shall be consistent with the Hartford Concrete Products, Inc. 4' x 4' x 4' utility handhole or an approved equivalent.

730.13 – Transformer Base.

730.14 – Conduit.

In addition to the T.D.O.T. Standard Section 730.14; Materials et al, the contractor shall comply with the following City of Franklin Standards:

1. All conduits shall be Schedule 80 P.V.C. unless otherwise noted. Installation of R.G.C. will be permitted upon approval of the Engineer in upgrades to existing facilities. A AWG #14 shall be pulled as a trace wire in any Fiber Optic Conduit run. Any Fiber Optic Conduit shall be terminated in a Type "B" pull box unless otherwise specified. Fiber Optic conduit shall have "Fiber Optic" warning tape installed a minimum of twelve (12) inches below finished grade.

2. For directional boring applications, High Density Poly-Ethylene (H.D.P.E.) conduit may be used. A AWG #14 shall be pulled as a trace wire in any Fiber Optic Conduit run. Any Fiber Optic Conduit shall be terminated in a Type "B" pull box unless otherwise specified.

All conduit installation shall utilize factory bends. Bends shall be "long sweep" specifically designed for electrically wiring applications. H.D.P.E. bends must maintain the minimum bend radius indicated by the manufacturer dependant on cabling (Fiber or Electrical) to be installed.

The contractor shall seal all open conduit entrance holes, with or without cables, with conduit Duct Seal putty. Where cables enter the conduit, the sealant shall be applied after installing the cable. These locations shall consist of conduit ends in pull boxes, cabinet bases and weatherheads.

All conduit installed shall include a "jet-line" for future conductor pulls and shall have a tracer wire for all Fiber Optic Conduit installations.

730.15 – Conductors.

In addition to the T.D.O.T. Standard Section 730.15 et al, the contractor shall install Stop Bar Detector loops that measure 6' x 45' with two turns of wire unless otherwise noted. Loops shall be centered in proposed lanes. Advance Detector loops shall measure 6' x 6' with three turns of wire unless otherwise noted. Loops shall be centered in proposed lanes.

730.16 – Cable.

730.17 – Wiring.

In addition to the T.D.O.T. Standard Section 730.17 et al, the contractor shall provide that loops and lead-in cable shall be continuous length; splices shall be permitted only in pull boxes or controller cabinets.

Label loops in cabinet in accordance with standard drawing T-SG-12. All wires shall be labeled in pull boxes on multi-lane approaches.

The contractor shall label all new and existing cables in the cabinet, pole/pedestal bases and pull boxes using the convention of drawing T-SG-12. Each wire shall be identified by a circular plastic tag, 1 3/8" diameter with preprinted lettering dies of minimum ¼ " height. Tags shall be permanently fastened to wire by means of nylon self clinching straps. Marking shall indicate "GRD" for all ground and grounded neutral conductors. Companion circuit conductors shall be marked "CKT" followed by the designated characters as shown on the plans.

730.18 – Service Connection.

In addition to the T.D.O.T. Standard Section 730.18 et al, the contractor shall be responsible for providing electrical service to the site. The contractor shall obtain an electrical permit from the City of Franklin Codes Department prior to constructing the installation.

The contractor shall provide AC service installation to supply the following:

a. 100 amp main breaker with one (1) 50 amp breaker for the Traffic Signal Installation, two (2) 25 amp breakers, one each for the illuminated signs and a spare.
b. Each 30 amp breaker shall be labeled for its use. Locate photocell for illuminated street name signs at the service disconnect.
c. Service shall be installed per the City of Franklin's Electrical Service Details for Traffic Signal Installation.

730.19 – Sealant.

In addition to the T.D.O.T. Standard Section 730.19 et al, the contractor shall install the inductive loop detector without flexible tube or backer rod.

730.20 – Strand Cable.

730.21 – Bonding and Grounding.

730.22 – Field Test.

In addition to the T.D.O.T. Standard Section 730.22 et al, the contractor shall place the Traffic Signal in flash operation for a minimum of seven (7) days prior to the activation of the signal to normal operation.

730.23 – Inspection.

SIGNAL HEADS

730.24 – Signal Heads.

GENERAL REQUIREMENTS

In addition to the T.D.O.T. Standard Section 730.24 et al, each vehicle signal head shall be of the adjustable, colored lens, vertical type with the number and type of lights detailed herein and as shown on the plans or specified in the bid documents; shall provide a light indicator in one direction only; shall be capable of adjustment (without attachments) through 360 degrees about a vertical axis; and shall be mounted as shown on the plans or as specified by the Engineer. The arrangement of the lenses in the signal faces shall be in accordance with Section 4B-9 of the M.U.T.C.D. Five-section cluster signals shall be assembled with the red section centered above the bottom four sections, in a configuration referred to as "dog house". All circular and arrow indications shall use twelve (12) inch lenses. All new signal heads installed at any one intersection shall be of the same style and from the same manufacturer. Signal housings shall be painted Federal Yellow and shall meet or exceed Federal Specifications TTC-595 Gloss Yellow. Signal faces, doors and visors shall be painted Gloss Black. Pedestrian pushbuttons shall be painted black.

Louvers as specified, and the interior of signal visors, shall have one or more coats of primer followed by two coats of Lusterless Black Enamel meeting or exceeding Federal Specifications TT-E-489. Coating of these components shall be by an electrostatic painting process that bakes on the enamel. All factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer. Factory applied enamel finish that remains in good condition and of appropriate color after installation will be acceptable.

Suspensions for span wire mounting of multi-faced signal heads and signal head clusters (such as a five-section signal head) shall include an approved swivel type balance adjuster for proper vertical alignment.

All signal heads must meet the minimum requirements for adjustable face Vehicle Traffic Control Signal Heads (VTCSH) as specified in ITE Publication No. ST-017B (1997).

MATERIAL

Signal heads shall be fabricated from cast aluminum. The signal housing shall be painted Federal Yellow. Door faces shall be painted Gloss Black. The door shall attach to the housing with stainless steel hinge pins, and be secured by stainless steel wing nuts. Visors shall be constructed of sheet aluminum and the exterior painted Gloss Black.

Visors shall be of the cutaway tunnel type, secured to the front section of the door with four stainless steel machine screws that thread into tapped holes in the door.

OPTICAL UNITS

Each signal section shall consist of a housing, door, visor, and 300 mm diameter signal illumination unit. All vehicular signal indications shall be the light emitting diode (LED) type conforming to the minimum performance requirements as described herein for the illumination unit. An LED signal module shall be capable of replacing the optical unit of an existing vehicle traffic signal section.

1. **Physical and Mechanical**

   LED traffic signal modules designed as retrofit replacements for existing signal lamps shall not require special tools for installation. Retrofit replacement LED signal modules shall fit into existing traffic signal housings built to the VTCSH “Vehicle Traffic Control Signal Heads” standard without modification to the housing.

   Installation of a retrofit replacement LED signal module into an existing signal housing shall only require the removal of the existing optical unit components, i.e., lens, lamp module, and gaskets. The LED retrofit replacement shall not require the removal of the reflector and socket; shall be weather tight and fit securely in the housing.

2. **Construction**

   The LED signal module shall be a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing. The power supply must be designed to fit and mount inside the traffic signal module. The external lens shall be smooth on the outside to prevent excessive dirt/dust buildup.

   The assembly and manufacturing process for the LED signal assembly shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources as per ITE requirements.

3. **Environmental Requirements**

   The LED signal module shall be rated for use in the ambient operating temperature range of -40ºC (-40ºF) to + 74ºC (+165ºF).

   The LED signal module shall be protected against dust and moisture intrusion per the requirements of NEMA Standard 250-1991, for Type 4 enclosures to protect all internal LED, electronic, and electrical components.

The LED signal module lens shall be UV stabilized.

4. LED Signal Module Lens

Each module shall comprise of a smooth surfaced UV stabilized polycarbonate outer shell. LEDs shall be mounted on a polycarbonate positioning plate. A mechanical alignment and assembly mechanism shall ensure that each LED is retained in a pre-determined position.

Red and Green LED indications shall exceed minimum ITE LED luminosity values and meet the minimum luminous intensity values per the attached Table 1, Specifications for Spanwire Mounted Signals.

Supply independent lab test results showing the LED indications satisfy ITE Chapter 2a, VTCHS Part 2: Light Emitting Diode (LED) Vehicle Signal Modules, and attached Table 1, Specifications for Spanwire Mounted Signals. No optical lens shall be used in order to meet these visibility requirements.

Initial intensity of the LED indications shall meet or exceed 120% of the values in Table 1, Specifications for Spanwire Mounted Signals. This increased intensity shall be demonstrated on the independent lab reports, to ensure the intensity levels of the LED's meet the Table 1 values at the end of the warranty period.

5. Materials

The multiple LED light source should be the latest technology available on the market. Materials used for the lens and signal module construction shall conform to ASTM specifications for the materials where applicable. Enclosures containing either the power supply or electronic components of the signal module shall be made of UL94VO flame retardant materials.

6. Chromaticity

The measured chromaticity coordinates of LED signal modules shall conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard.

7. Electrical

All wiring and terminal blocks shall meet the requirements of Section 13.02 of the VTCSH standard. Two secured, color-coded, 914 mm (36 in) long 600 V, 20 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +105ºC, are to be provided for electrical connection.

The module shall operate on a 60 Hz AC line voltage ranging from 80 volts rms to 135 volts rms with less than 10% light intensity variation. Nominal rated voltage for all measurements shall be 120 ± 3 volts rms. The circuitry shall prevent flickering over this voltage range. The module shall be ETL certified to meet applicable ITE standards (red and green).

8. LED Drive Circuitry (Power Supply)

The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will result in the loss of only that one LED light source in the LED signal module. The power supply must be current regulated.

9. Electronic Noise

The LED signal and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

10. Power Factor (PF)

The LED signal module shall provide a power factor of 0.90 or greater at 25ºC and at the nominal operating voltage.

11. AC Harmonics

Total harmonic distortion (THD), (current and voltage), induced into an ac power line by a signal module shall not exceed 20 percent, over the operating voltage range specified in Section 14 and within the ambient temperature range specified in Section 3.4.

12. Transient Voltage Protection

The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992.

13. Voltage Range

The LED signal module shall operate from a 60 ± 3 HZ ac line power over a voltage range from 80 Vac rms to 135 Vac rms. The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in signal controller units the procuring traffic authority customer has in use.

14. Signal Module Burn-in

All LED signal modules shall be energized for a minimum of 24 hours, at 100 percent on-time duty cycle, in an ambient temperature of 60ºC (+140ºF).

15. Design Qualification Testing

Design Qualification testing shall be performed on new LED signal module designs, and when a major design change has been implemented on an existing design.

Testing shall be performed once every 5 years or when the module design or LED technology has been changed. Test data shall be retained by the manufacturer for a minimum period of 5 years.

16. Quality Assurance

LED signal modules shall be manufactured in accordance with a vendor quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance includes statistically controlled routine tests to ensure minimum performance levels of LED signal modules built to meet this specification.

QA process and test results documentation shall be kept on file for a minimum period of seven years.

17. Certificate of Compliance

Manufacturers shall provide a Certificate of Compliance to this specification for each shipment of LED signal modules to an end user. Each LED signal module shall be identified with a serial number. The manufacturer shall supply independent lab test results showing the red and green LED indications satisfy ITE Chapter 2a, VTCHS Part 2: Light Emitting Diode (LED) Vehicle Signal Modules, and attached Table 1, Specifications for Spanwire Mounted Signals. Initial intensity of the LED indications shall meet or exceed 120% of the values in Table 1, Specifications for Spanwire Mounted Signals. This increased intensity shall be demonstrated on the independent lab reports, to ensure the intensity levels of the LED's meet the Table 1 values at the end of the warranty period.

The manufacturer shall also participate in the ETL traffic control equipment certification program.

Table 1 - Specifications for Span Wire Mounted Signals

SPECIFICATION FOR RED SIGNALS

EXTENDED VIEW

	27.5	22.5	17.5	12.5	7.5	2.5	-2.5	-7.5	-12.5	-17.5	-22.5	-27.5
22.5			20			20	20			20		
17.5	16	20	22	22	22	22	22	22	22	22	20	16
12.5	16	22	34	44	48	50	50	48	44	34	22	16
7.5	16	38	89	145	202	226	226	202	145	89	38	16
2.5			77	141	251	339	339	251	141	77		
-2.5			77	141	251	339	339	251	141	77		
-7.5	16	38	89	145	202	226	226	202	145	89	38	16
-12.5	16	22	34	44	48	50	50	48	44	34	22	16
-17.5	16	20	22	22	22	22	22	22	22	22	20	16
-22.5			20			20	20			20		
-27.5			20			20	20			20		
-32.5			20			20	20			20		

SPECIFICATION FOR GREEN AND AMBER SIGNALS

EXTENDED VIEW

	27.5	22.5	17.5	12.5	7.5	2.5	-2.5	-7.5	-12.5	-17.5	-22.5	-27.5
22.5			40			40	40			40		
17.5	32	40	44	44	44	44	44	44	44	44	40	32
12.5	32	44	68	88	96	100	100	96	88	68	44	32
7.5	32	76	178	290	404	452	452	404	290	178	76	32
2.5			154	282	502	678	678	502	282	154		
-2.5			154	282	502	678	678	502	282	154		
-7.5	32	76	178	290	404	452	452	404	290	178	76	32
-12.5	32	44	68	88	96	100	100	96	88	68	44	32
-17.5	32	40	44	44	44	44	44	44	44	44	40	32
-22.5			40			40	40			40		
-27.5			40			40	40			40		
-32.5			40			40	40			40		

From TO-7057, rev.02/15/2002 of Texas DOT available on the web

NOTES

1 The ITE portion (highlighted in yellow) match ITE requirements for LED modules
2 Signal modules should be designed to meet these requirements at the end of the warranty period
3 Initial intensity of the signal modules should meet 120% of the above requirements
4 Independant laboratory test reports should be required to validate initial intensity

18. Warranty

Manufacturer will provide the following warranty provisions:

(1) Replacement or repair of an LED signal module that fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.

(2) Replacement or repair of LED signal modules that exhibit luminous intensity of less than the minimum values specified in ITE specification VTCSH-Part-2 July 1998, and Table 1, Specifications for Span Wire Mounted Signals, within the first 60 months from the date of delivery.

EXTERIOR FINISH

All exterior parts facing the intended traffic movement shall be painted Gloss Black, unless otherwise noted.

The insides of visors and the entire surface of louvers or fins used in front of traffic signal lenses shall be finished a dull black as specified in these specifications (see Subsection - General Requirements).

SIGNAL HEAD MOUNTING AND MOUNTING BRACKETS

Signal heads shall have integrally cast serrations and shall be equipped with positive lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall be serrated contacts. Signals shall be provided with water-tight fittings using neoprene washers.

Bracket mounted signal heads, as shown on the plans, shall be supported by mounting brackets consisting of assemblies of 1 ½" standard pipe size. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within poles and mounting assembly. Each slip fitter shall be secured to the pole with at least three stainless steel machine bolts.

DIRECTIONAL LOUVERS

Where shown on the plans, louvers shall be furnished and installed in the hoods of the signal head sections designated.

Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder and vanes shall be constructed of a non-ferrous metal. Louvers shall be primed and then painted with two coats of dull black enamel as specified in these specifications (see Subsection 1.0 – General Requirements).

BACK PLATES

Backplates, where shown on the plans, shall be furnished and attached to the signal heads. All back plates shall be louvered on each of the four sides of the panel, and constructed of 0.051" minimum thickness vacuum-formed black polycarbonate material. In fabricating back plates, the inside vertical edges, adjacent to the signal head, shall be bent back forming mounting brackets for attaching to the signal. Back plates that are formed in two or more sections and bolted together, thus permitting installation after signal heads are in place, will be acceptable. Back plates shall have a dull black appearance.

WIRING

Signal head leads shall be No. 18 AWG stranded with 2/64", 105 degrees C Thermoplastic insulation. A separate white (common) lead shall be wired to each socket shell; and a colored lead, corresponding to the lens color, shall be wired to each socket terminal. Leads shall be of sufficient length to allow connection to the terminal block specified herein. Each complete signal head shall be provided with a 4-point terminal block, properly mounted in a signal section. Stud type terminal blocks shall have not less than 1/4 edge clearance to any portion of the stud. Exterior wiring shall have a 360 degree drip loop in advance of entering the head.

PEDESTRIAN SIGNALS

When shown on the plans, pedestrian signals shall conform to the following:

General Requirements

Pedestrian LED traffic signal modules shall be designed as a retrofit replacement for the message bearing surface of a 16” × 16” pedestrian traffic signal housing built to the PTCSI Standard, or a two-section 12” × 12” pedestrian traffic signal housing built to the PTCSI Standard. The message-bearing surface of the module shall be supplied with the solid “HAND” and “MAN” symbols that comply with the PTCSI standard for this symbol for a message-bearing surface of the size specified. This message-bearing surface shall be designed so that it can be removed from the sealed unit for replacement without further damage to the module.

1. **Physical and Mechanical**

   LED pedestrian signal modules shall be designed as retrofit replacements for the existing pedestrian signals.

LED pedestrian signal modules shall not require special tools for installation.

LED pedestrian signal modules shall fit into the existing traffic housings built to the VTCSH Standard without any modification to the housing.

LED pedestrian signal modules shall be weather tight, fit securely in the housing and shall connect directly to existing electrical wiring.

Installation of a replacement LED module into the existing pedestrian housing shall only require the removal of the existing optical unit components, i.e., lens, lamp, gaskets, and reflector.

Each retrofit shall include all necessary components to complete conversion including a one-piece gasket.

Each pedestrian module shall have a sticker attached stating compliance to the ITE Standard for color and size of symbols.

2. Pedestrian Lenses

The lens of the LED pedestrian signal modules shall be field replaceable.

The lens of the LED pedestrian signal modules shall be polycarbonate UV stabilized and a minimum of 3/16 ” thick.

The exterior of the lens of the LED pedestrian signal module shall be smooth and frosted to reduce sun phantom.

3. Construction

The LED pedestrian signal module shall be a single, self-contained device, not requiring on-site assembly for installation into the existing traffic signal housing
.
All Portland Orange LEDs shall be “AlInGaP” technology or equal, and rated for 100,000 hours or more at 25ºC and 20 mA. “ALGaAS ” technology is not acceptable. All white LEDs shall be "InGaN" Technology or equal, and rated for 100,000 hours or more at 20^{o}C and 10mA.

All internal LED and electronic components shall be adequately supported to withstand mechanical shock and vibration from high winds and other sources.

The signal module shall be made of UL94VO flame-retardant materials. The lens is excluded from this requirement.

Each individual LED traffic module shall be identified for warranty purposes with the manufacturer's trade name, serial number and operating characteristics, i.e., rated voltage, power consumption, and volt-ampere.

4. **Environmental Requirements**

The LED pedestrian signal modules shall be rated for use in the ambient operating temperature range of -40ºC to +60ºC (-40ºF to +140ºF).

The LED pedestrian signal modules, when properly installed with gasket, shall be protected against dust and moisture intrusion per requirements of NEMA Standard 250-1991, sections 4.7.2.1 and 4.7.3.2, for type 4 enclosures to protect all internal LED, electronic, and electrical components.

5. **Luminous Intensity**

Pedestrian LED signal modules shall be designed so, that when operated over the specified ambient temperature and voltage range, the signal shall attract the attention of, and be readable to, a viewer (both day and night) at all distances from 3 m to the full width of the area to be crossed. The luminous intensity of the LED pedestrian signal module shall not vary more than ± 10 % for voltage range of 80 VAC to 135 VAC.

6. **Chromacity**

The measured chromaticity coordinates of the LED signal modules shall conform to the chromaticity requirements of Section 5.3 and Figure C of the PTCSI standard.

7. **Electrical**

The secured, color coded, 914 mm (36 in) long, 600V, 20 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +105ºC, ½ inch stripped and tinned are to be provided for electrical connection.

The LED pedestrian signal module shall operate from a 60 ±3 Hz AC line over a voltage range of 80 VAC to 135 VAC. Rated voltage for all measurements shall be 120 ±3 volts rms.

The LED circuitry shall prevent perceptible flicker over the voltage range specified above.

The LED pedestrian signal module circuitry shall include voltage surge protection against high-repetition noise transients and low-repetition noise transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992.

Catastrophic failure of one LED light source shall not result in the loss of more than the light from that one LED.

The LED pedestrian module shall be operationally compatible with the currently used controller assemblies. The LED pedestrian module shall be operationally compatible with conflict monitors.

The LED pedestrian module including its circuitry must meet Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of noise.

The LED pedestrian module shall provide a power factor of .90 or greater over the operating voltage range and temperature range specified above.

Total harmonic distortion induced into an AC power line by an LED pedestrian module shall not exceed 20% over the operating voltage range and temperature range specified above.

8. Quality Assurance

LED pedestrian modules shall be manufactured in accordance with a Vendor quality assurance (QA) program including both design and production quality assurance. All QA process and test results documentation described below shall be kept on file for a minimum of seven years.

9. Production Quality Assurance

The following Production Quality Assurance tests shall be performed on each new LED signal module prior to shipment. Failure to meet requirements of any tests shall be cause for rejection.

- **a.** Pedestrian Module Burn-In – All LED signal modules (or boards) shall be energized for a minimum of 24 hours, at 100 percent duty cycle, in an ambient temperature of 60ºC (140ºF).
- **b.** After burn-in, all LED pedestrian modules shall be tested for power factor and shall meet the requirements defined in this specification.
- **c.** After burn-in, all LED pedestrian modules shall be measured for current flow in amperes. The measured current values shall not exceed 110% of the design qualification measurements (described in the next section).
- **d.** All LED pedestrian modules shall be visually inspected for any exterior physical damage or assembly anomalies. Careful attention shall be paid to the surface of the lens to ensure there are no scratches, cracks, chips, discoloration, or other defects.

10. Design Qualification Testing

Design Qualification testing described below shall be completed documented and submitted with the equipment quotation. All Design Qualification testing shall be performed after a burn-in (module energized for a minimum of 24 hours, at 100 percent duty cycle, in an ambient temperature of +60ºC (+140ºF).

- **a.** The LED pedestrian modules shall be measured for wattage by an independent testing laboratory.
- **b.** The LED pedestrian module shall be measured for chromaticity per the requirements defined in this specification at an ambient temperature of +25ºC (+77ºF) by an independent testing laboratory.
- **c.** The LED pedestrian modules shall be measured for power factor per the requirements defined in this specification by an independent testing laboratory.
- **d.** The LED modules shall be measured for total harmonic distortion per the requirements defined in this specification by an independent testing laboratory.
- **e.** The LED pedestrian modules shall be tested for electronic noise per the requirements defined in this specification with reference to Class A emission limits referenced FCC Title 47 Subpart B, Section 15 by an independent testing laboratory.
- **f.** The LED pedestrian modules shall be tested for transient immunity (e.g. early electronic component mortality failures, component reliability problems) using NEMA Standard TS 2-1992 by an independent testing laboratory.
- **g.** Mechanical vibration testing shall be performed on the LED pedestrian modules, by an independent testing laboratory, in accordance with MIL-STD-883, Test Method 2007, using three 4 minute cycles along each x, y, z axis, at a force of 2.5 Gs, with a frequency sweep from 2 Hz to 120 Hz. The loosening of the lens, of any internal components, or other physical damage shall be cause for rejection.
- **h.** Temperature cycling shall be performed on the LED pedestrian modules, by an independent testing laboratory, in accordance with MIL-STD-883, Test Method 1010. Using the temperature range of -40ºC to +60ºC (-40ºF to +60ºF), twenty cycles (minimum) with a thirty-minute transfer time between temperature extremes and with a thirty minute dwell time at each extreme shall be performed. Modules under test shall not be energized. Modules that fail to function properly or show evidence of cracking of the lens or housing shall be rejected.

NOTE: With respect to design changes, if the construction of the modules has not been modified, documentation of testing described in items e, g, and h on older models is acceptable at time of bid. Updated documentation will be required prior to first shipment.

11. Manufacturer Qualification

- **a.** Manufacturer/Distributor/Vendor must have experience with furnishing
- **b.** LED lighting for the installation of at least 5,000 LED traffic signals on any one project.

12. Warranty

The unit shall be repaired or replaced by the contractor if it exhibits a failure due to workmanship or material defect within the first 60 months of delivery.

- **a.** The unit shall be repaired or replaced by the contractor if it exhibits a failure due to workmanship or material defect within 60 months of delivery.
- **b.** The unit shall be repaired or replaced if the intensity level falls below 50% of the original values within 36 months of delivery.

Any signal heads when visible to drivers, but not operational, shall be completely covered.

CONTROLLERS - GENERAL

730.25 – Controllers.
In addition to the T.D.O.T. Standard Section 730.26 et al, the contractor shall at a minimum of thirty (30) days prior to turn on, contact the City of Franklin Traffic Operations Center (615) 550-6672 to arrange the delivery of the new controller for programming by the city. Upon city installation of the timings in the controller, the contractor shall retrieve the controller and install it at the intersection.

730.26 – Traffic Actuated Controllers.

In addition to the T.D.O.T. Standard Section 730.26 et al, the contractor shall provide a signal controller and cabinet equivalent to an 8-Phased Eagle EPAC 300 Series with coordination. The cabinet shall provide for a minimum of twelve (12) signal circuits and load bay positions.

730.27 – Auxiliary Equipment for Traffic Actuated Controllers

In addition to the T.D.O.T. Standard Section 730.27 et al, the contractor shall provide a signal cabinet and auxiliary equipment to allow for full eight (8) phase operation irrespective of intersection design.

The contractor shall install a 3M Opticom emergency vehicle priority control system in conjunction with the traffic signal installation. Priority control shall be provided on the applicable approaches of the intersection as indicated on the plans. Detector cable model 138 shall be provided by the contractor as required.

FLASHING SCHOOL SIGNALS

730.28 – Flashing School Signals.

In addition to the T.D.O.T. Standard Section 730.28 et al, the signal heads used for school or warning flashers shall conform to Section 730.24 of the T.D.O.T standards and these supplemental specifications.

DETECTORS

730.29 – Detectors.

In addition to the T.D.O.T. Standard Section 730.29 et al, the contractor shall provide loop detector amplifiers that are single channel for shelf placement. Each loop shall have its own distinct circuit (channel).

730.30 – Coordination.

In addition to the T.D.O.T. Standard Section 730.30 et al, the contractor shall supply all appurtenances required to have a complete and operating interconnected system traffic signal if required. For the City of Franklin compatibility the equipment shall be:

a. *RADIO SYSTEM:* The controller shall be an Eagle EPAC 3108-M52 with comm. module AAD15288P009. The radio transceiver shall be MDS9810 installed, configured and performance optimized according to ITS installation and operation guide, using a hand held terminal to be delivered to the City of Franklin. Radio Interconnect installation shall include Yagi Antenna (MDS #TY900), power supply (ASTRON #RS-3A), coax cable (LMR-600) from antenna to coax protector (EDCO CX-HFN), coax cable (LMR-240) from coax protector to radio and data protector (EDCO SRS-232-25). Master radio location shall be determined by the City of Franklin.

b. *FIBER OPTIC:* The controller shall be an Eagle EPAC 3108-M52 with comm. module AAD15288P009. A minimum12-position fiber optic distribution panel shall be installed in the cabinet.

730.31 – Time Base Coordination Units

TRAFFIC SIGNAL SUPPORTS

730.32 – Cantilever Signal Supports.

In addition to the T.D.O.T. Standard Section 730.32 et al, the contractor and/or the pole fabricator shall determine the size and design of all steel signal support poles and foundations. Shop drawings for the proposed poles shall be submitted to the City of Franklin Engineering Department for review and approval. The steel supports shall be finished by the manufacturer in a black gloss color and shall be touched up as needed by the contractor.

730.33 – Steel Strain Poles.

In addition to the T.D.O.T. Standard Section 730.33 et al, the steel supports shall be finished by the manufacturer in a black gloss color and shall be touched up as needed by the contractor.

730.34 – Pedestal Support Signal Poles.

In addition to the T.D.O.T. Standard Section 730.34 et al, the steel supports shall be finished by the manufacturer in a black gloss color and shall be touched up as needed by the contractor.

730.35 – Wooden Signal Support Poles.

730.36 – Pole Location.

In addition to the T.D.O.T. Standard Section 730.34 et al, the proposed locations of signal support poles and controller as shown on these plans are approximate. Some field adjustment may be required in order to avoid conflict with either underground, above ground, or overhead utilities. The contractor shall be responsible for determining and staking the optimum locations for the poles/controller and for receiving approval from the City of Franklin Engineering Department before installation begins. Proper roadside clear zones shall be observed.

COMPENSATION

730.37 – Method of Measurement.

In addition to the T.D.O.T. Standard Section 730.37 et al, vehicle loop amplifier shall conform to Section 730.29 of the T.D.O.T standards and these supplemental specifications.

Utility companies will be responsible for the relocation and/or removal of their poles and equipment. The poles and equipment to be removed by the Contractor have been generally noted on the Plans; however, it is the intent of these Specifications to have the Contractor remove any traffic control related equipment that is in conflict with the proposed equipment and deliver to the City of Franklin Streets Department facility.

The City of Franklin
Streets Department
108 Southeast Parkway
Franklin, TN 37064
Office: (615) 791-3254
Fax: (615) 791-3200

All new or temporary signals, shall be removed and stockpiled in such a manner that the removed equipment will not be damaged. Poles shall be removed complete and undamaged. The pole shall be cleaned of any concrete foundation material. Any damage due to negligence on the part of the contractor because of lack of proper care of equipment shall be cause for the contractor to replace in kind. The cost of such replacement shall be borne fully by the contractor without extra compensation. All such removed and salvageable equipment is now and shall remain the property of the City of Franklin.

730.38 – Basis of Payment.

INTERNALLY ILLUMINATED STREET NAME SIGNS

The LED internally illuminated signs are not brand specific but should comply with the materials standards outlined in the Materials, Mechanical, Electrical, and Optical Performance ratings of this specification. This specification shall govern for LED (light emitting diode) internally illuminated street name signs attached to traffic pole shafts and or mast arms. All materials used in fabrication shall be new and of good quality.

SNS - 1.0 MECHANICAL SPECIFICATIONS

SNS - 1.1 Sign Dimensions:

The LED internally illuminated street name sign shall be capable of being constructed in standard widths from 12 inches up to 8 feet in length, according to the legend.

The height of the signs shall be 22 inches to accommodate 12-inch upper case letters and 2.5-inch clearances from the vertical sides. Street name legend shall be mixed upper and lower case letters, with a superscripted extension.

The sign should be a maximum depth of 1.5 inches for single sided signs.

SNS - 1.2 Environmental Requirements:

The sign fixture shall be designed and constructed to prevent deformation or failure when subjected to 121 km/h (75 mph) wind loads in conformance with the requirements of the AASHTO I publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaries and Traffic Signals", and all associated updated amendments

The sign fixture should be able to withstand and operate at temperature extremes of -40deg F to 125deg F.

The sign fixture should be able to withstand salt spray and moisture.

SNS - 2.0 MATERIALS

SNS - 2.1 Materials:

All materials furnished by the Manufacturer/Vendor/Contractor shall be in accordance with the NEC.

Signs shall have a single side message as shown on the design sheet. The text message should be bright white letters etched and paint filled into the acrylic. The background shall be a green high intensity retro reflective film of diamond grade VIP material by 3M Company, or approved equal.

The Manufacturer/Vendor shall supply shop drawing submittals on the fixtures, sign, sign message and mounting hardware. Where the Manufacturer/Vendor has not previously supplied the item to the City of Franklin or its Contractors, that Supplier shall provide a full-size physical prototype of all equipment to the City for inspection, review and approval.

The materials used in the sign shall be the following or their equivalent: Protection face: 3M 1160 Series sheeting with ultra violet protection, and abrasive and mar resistant. Sign face: Cast acrylic 9mm. Sign back: Extruded acrylic 3mm. Aluminum back plate: Utility aluminum 1/8". Top and bottom extrusion: Extruded aluminum alloy 6063 with baked-on gloss black enamel. End caps: Utility aluminum gauge 12. Mounting brackets: Utility aluminum 1/8". All fasteners shall be stainless steel. Gaskets: Polyethylene.

SNS - 2.2 Housing:

The sign frame/housing and backing shall be formed and manufactured out of extruded aluminum alloy 6063 with a minimum tensile strength of 25,000 ksi.

The sign frame and backing shall be finished with a baked-on enamel process in gloss black. The sign frame and housing shall incorporate stainless steel fasteners to secure the sign in the closed position.

The end caps shall have an internal gasket installed to seal against the top and bottom extrusions.

SNS - 2.3 Sign Panels:

The sign panel shall be slide mounted in the frame and accessible by removal and reinstallation of the top frame or by a door with continuous hinging along the bottom of the front panel frame.

The entire surface of the sign panel shall be evenly illuminated so that the surface of a 1ft x 1ft section of the sign has a light output of a minimum of 50 nits with a maximum degradation to 15 nits after 5 years.

The protection film shall be a clear transparent overlay of high impact UV resistant plastic/acrylic material able to withstand 5 years of <400nm UV light. All surfaces shall be free of blemishes in the plastics or coating that might impair the service of detract from the general appearance and color matching of the sign.

SNS - 2.4 Hardware:

The sign shall be rigid-mounted to a pole shaft or mast arm. The method of mounting shall be by banding. Unless otherwise shown on the plans or required in this specification, all fasteners and screws in or on the fixture shall be stainless steel type 302 or 305, brass or aluminum. All steel nuts, bolts, and hardware for sign attachment shall be stainless steel type 302 or 305.

The plans are to show the location on the mast arms for the clamp-on street signs, when required, as well the location and details for the wire entrance. Offset mounting brackets with clamps and adapters shall be attached at two-foot spacing on the back side panel for use of Band-It material to rigidly mount the sign to the mast arm. The sign bracket itself shall clamp the top and bottom frame of the sign. The adapters shall swivel around the mid-height level of the sign, and be lockable to allow for leveling of the sign.

All wiring connections within the sign fixture shall terminate through an U.L. approved junction box.

All conductors inside the sign fixture and on the load side of the power source shall be U.L. listed appliance material (no smaller than #14 AWG) stranded copper wire with thermoplastic insulation.

SNS – 3.0 ELECTRICAL

SNS - 3.1 Light Source:

The LED internally illuminated street name sign light modules shall be composed of white LEDs with a minimum viewing angle 110º mounted on rugged metal boards consuming no more than 1.5 Watts per linear foot, with a thermal resistance path from the LED pin to the most external surface of the aluminum extrusion of no more than 20ºC/Watt at an ambient temperature of 25ºC to reduce wear and tear on the individual LEDs and to extend useable lifetime. The LED light modules should be thermally coupled directly to the aluminum extrusion using thermal adhesive transfer tape. The LED light modules should be mounted to project light into the border of an optically coupled light panel. The light panel redirects the light to create a uniform illuminated plane with minimum candelas per meter squared of 50nits at initial turn on and no less than 15nits after 5 years. For each linear foot of sign, a combination of one top and one bottom LED Light module shall be used. Each LED Light module board shall be replaceable by disassembly of the sign. All interconnections between LED light modules should be hard solder connections to eliminate thermal fatigue and micro cracking associated with power cycling.

SNS - 3.2 Electrical Power Source/Power Supply:

The sign shall be powered by a 120-vac to 12Vdc Class II UL approved grid utility source. The power source should be capable of performing as one power supply to light all signs at the intersection, with a maximum voltage drop of 3% at any individual sign. This type of power source should have four (4) independent channels with a maximum load per channel of 60Watts or 240Watts total. All power sources should be enclosed in a NEMA 3R approved box or in the traffic signal cabinets.

SNS - 3.3 Auto On/Off Switch:

An automatic ON/OFF twilight sensor switch located either before the sign power supply or on the initial LED light module shall control the time the LED's should be on or off.

In the event that the sensor switch is to be located on the initial LED module, it should be mounted as the first electrical contact point in the sign and should be mounted directly adjacent to the first LED light module. The twilight sensor shall also be optically coupled to the light panel. The twilight sensor shall be capable of handling a maximum power of the rated load of the sign to allow for ample guard banding to power up to a 10 ft long sign. The twilight sensor should be blind to light ranges from 285nm to 700nm and should not be false triggered by direct coupling with LED light modules.

The maximum power per foot of sign shall not exceed 1.5watts maximum, except if a twilight sensor is used then the max power for the first 1" of the sign shall not exceed 2.5 Watts.

SNS - 3.4 Surge/Induced Lightning Protection:

A protection circuit can be included to provide up to 1000 Watts of protection for 1 millisecond pulse to protect against transients induced by lightning and inductive load switching. The protection device should have a response time of 1 X 10^{-12} seconds so it is also effective in protecting against electrostatic discharge and NEMP in the case of improper handling of the sign.

The protection circuit should be integral to the first LED Light module in the street name sign.

SNS - 3.5 Back Up Power:

Auxiliary back up power systems shall not be required with these signs.

SNS - 4.0 OPTICAL PERFORMANCE

SNS - 4.1 Light Output:

The sign shall be able to produce 50 nits at initial installation, or 15nits after a period of 5 years. Measurements of light output and compliance with safety requirements can be made using a chromo meter.

SNS - 5.0 WARRANTY, MAINTENANCE, AND SUPPORT

The contractor shall obtain and assign to the City where the sign is installed all manufacturers' guarantees or warranties which are normally provided as customary trade practice for items and materials incorporated into the work. In the absence of a manufacturer's guarantee, the Contractor shall warrant that mechanical and electrical equipment and material incorporated into the work are free from any defects or imperfections in workmanship and material for a period of one (1) year after final acceptance of the project. The Contractor shall be responsible for repairing any malfunction or defect in any such equipment or material, which develops during the one (1) year period.

PAVEMENT MARKINGS

PM - 1.0 Description.

In addition to the T.D.O.T. Standard Section 716 et al, all stop lines and pavement arrows shall be a preformed pliant polymer material or thermoplastic material. Stop lines shall be 24 inches wide.

New Pavement markings shall be of a preformed pliant polymer material or thermoplastic material and applied to areas not already marked. In transition areas, new pavement markings shall be extended 20 feet into existing pavement markings. Existing pavement markings shall be reapplied as needed.

PM - 2.0 Materials.

Material, equipment, and hardware furnished under this section must be pre-approved by the Engineer.

PM - 3.0 Construction Methods.

In accordance with the T.D.O.T. Standard Section 712 et al.

PM - 4.0 Method of Measurement.

In accordance with the T.D.O.T. Standard Section 712 et al.

FIBER-OPTIC CABLE

All construction, materials, equipment, workmanship and installation procedures shall comply with the T.D.O.T. Standard Specifications for Road and Bridge Construction, March 1, 1995 (as amended) Section 730.01 et al, and with these current standards and specifications of the City of Franklin.

FIBER OPTIC CABLE (OSP)

All Outside plant trunk cables used in the project shall be stranded loose tube design. Drop cables shall be central core or stranded loose tube design. The cable configurations shall be dictated by the particular communication path, data rate, & distance of the optical path.

Cable configurations required for this project are displayed in the plans.

FOC - 1.1 FIBER OPTIC CABLE (OSP)

FOC - 1.1 General Considerations

The cable shall meet all requirements stated in this specification. The cable shall be a listed product of the United States Department of Agriculture Rural Utilities

Services (RUS) 7 CFR1755.900 and the ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-1992.

The cable shall be new, unused, and of current design and manufacture.

FOC - 1.2 Fiber Characteristics

All fibers in the cable must be usable fibers and meet required specifications.

Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.

SINGLE-MODE: The single-mode fiber utilized in the cable specified herein shall conform to the following specifications:

- Typical Core Diameter: 8.3 µm.
- Cladding Diameter: 125.0 ± 1.0 µm.
- Core-to-Cladding Offset: $\leq$0.8 µm.
- Cladding Non-Circularity: $\leq$ 1.0%. Defined as: [1-(min. cladding dia. max. cladding dia.)] X 100
- Coating Diameter: 245 ± 10 µm.
- Colored Fiber Diameter: nominal 250 µm.
- Attenuation Uniformity- No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.
- Attenuation at the Water Peak- The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.
- Cutoff Wavelength- The cabled fiber cutoff wavelength ($\square_{ccf}$) shall be < 1250 nm.
- Mode-Field Diameter: 9.30 ± 0.50 µm at 1310 nm 10.50 ± 1.00 µm at 1550 nm
- Zero Dispersion Wavelength ($\square_o$)- 1301.5 nm $\leq \square_o \leq$1321.5 nm.
- Zero Dispersion Slope (S_o)- $\leq$0.092 ps/(nm^{2}km).

- Polarization Mode Dispersion ≤0.5 ps/sq.rt. km

The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer.

The coating shall be mechanically strippable without damaging the fiber.

FOC - 1.3 Fiber Specification Parameters

Required Fiber Grade - Maximum Individual Fiber Attenuation for single-mode fibers shall be 0.40dB/km @ 1310nm, 0.30dB/km @ 1550.

The maximum dispersion shall be ≤3.2 ps/(nm_km) from 1285 nm through 1330 nm and shall be ≤18 ps/(nm_km) at 1550 nm.

FOC - 1.4 Specifications for Outdoor Trunk Cables

Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm.

Each buffer tube shall contain up to 12 fibers.

The fibers shall not adhere to the inside of the buffer tube.

Each fiber shall be distinguishable from others by means of color coding in accordance with EIA/TIA-598-A, "Optical Fiber Cable Color Coding." The ink for coloring fibers shall be UV cured, no thermal inks shall be used in the coloring process.

Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with EIA/TIA- 598, "Optical Fiber Cable Color Coding."

- Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

- For dual layer buffer tube construction cables, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink back requirements of 7 CFR 1755.900.

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "SZ", stranding process. Water blocking yarn(s) shall be applied longitudinally along the central member during stranding.

For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter. Dual layer cables shall be water blocked in a similar fashion.

Two polyester yarn binders shall be applied contra helically with sufficient tension to secure the buffer tube layer to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.

The cable shall contain at least one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength aramid yarns and/or fiberglass yarns.

The high tensile strength aramid yarns and/or fiberglass yarns shall be helically stranded evenly around the cable core.

The cable shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be free of holes, splits, and blisters.

The cable jacket shall contain no metal elements and shall be of a consistent thickness.

The cable jacket shall be marked with "'Manufacturer' Optical Cable," sequential foot markings, year of manufacture, fiber count and fiber types, EX (72f, 36 sum, and 36 mm 62.5/125). The actual length of the cable shall be within -0±1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm.

The maximum pulling tension shall be 2700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40degreeC to ±70degreeC. The installation temperature range of the cable shall be -30degreeC to ±70degreeC.

FOC - 1.5 Specifications for Drop Cable (to Controllers, VMS, Camera locations, etc.).

Optical fibers shall be placed inside a single loose buffer tube.

The buffer tube shall contain at minimum 6 and up to 12 fibers.

The fibers shall not adhere to the inside of the buffer tube.

Each fiber shall be distinguishable from others per Item FOC – 1.4.

The colors shall be stable during temperature cycling an not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

The buffer tube shall be filled with a non-hygroscopic, nonnutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

The cable core interstices shall be filled with a water-blocking compound or water blocking strength members. The compound, if used in the design shall be a thixotropic gel containing a Super Absorbent Polymer (SAP) material. The gel shall be non-nutritive to fungus, electrically non-conductive and homogenous.

The gel shall be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

The cable shall contain at least one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength yarns.

The high tensile strength yarns shall be helically stranded evenly around the central tube.

The cable shall be sheathed with UV resistant jacketing compound. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking compound. The jacketing material shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be free of holes, splits, and blisters.

The cable jacket shall contain no metal elements and shall be of a consistent thickness. The maximum diameter of the cable shall not exceed .50 inches.

The cable jacket shall be marked with "'Manufacturer' Optical Cable," sequential foot markings, year of manufacture. The actual length of the cable shall be within -0±1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm.

The maximum pulling tension shall be a minimum of 300 lbf during installation (short term) and 115 lbf long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40degreeC to ±70degreeC. The installation temperature range of the cable shall be -30degreeC to ±70degreeC.

FOC - 1.6 General Cable Performance Specifications for OSP cables

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40degreeC to ±70degreeC) shall not exceed 0.2 dB/km at 1550 nm for single-mode fiber and 0.5dB/km at 1300 nm for multimode fiber.

When tested in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable." a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", the cable shall exhibit no flow (drip or leak) of filling or flooding compound at 65degreeC.

When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables, the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of sample. The load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes. The change in attenuation shall not exceed 0.4 dB during loading and 0.2 dB after loading at 1550 nm for single-mode.

When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand 25 impact cycles. The change in attenuation shall not exceed 0.2 dB at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N (608 lbf). The change in attenuation shall not exceed 0.2 dB during loading and 0.1dB after loading at 1550 nm for single- mode.

When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 4 meters will withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-37, “Low or High Temperature Bend Test for Fiber Optic Cable”, the cable shall withstand four full turns around a mandrel of 10 times the cable diameter after conditioning for four hours at test temperatures of -30degreeC and $\pm$60degreeC. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears or other openings. Optical continuity shall be maintained throughout the test.

FOC - 1.7 Quality Assurance Provisions

All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

All optical fibers > 1000 meters shall be 100% attenuation tested. The attenuation of each fiber at both operational windows shall be provided with each cable reel.

The cable manufacturer shall be ISO 9001 registered.

FOC - 1.8 Packaging

Top and bottom ends of the cable shall be available for testing.

Both ends of the cable shall be sealed to prevent the ingress of moisture.

Each reel shall have a weatherproof reel tag attached identifying the reel and cable.

FOC - 1.9 Pre-Terminated Drop Cable Assemblies

These assemblies shall be employed when connecting a camera, controller, VMS or other device the main cable when mid-span access techniques are used.

Cable used for Drop cable assemblies shall conform to section FOC – 1.5.

Assemblies shall be factory assembled & terminated on one end with ceramic ferrule, ST compatible, heat cured epoxy connectors with an operational temperature of -40C to $\pm$70C. Each connector shall have a minimum of a 1-inch strain relief boot.

Insertion loss for each connector shall not exceed .30dB for both single mode assemblies. Return loss for single mode connectors shall be >-45dB. Each assembly is to be fully tested and those test results placed on a test tag for each assembly. Each assembly is to be individually packaged within a box or reel, with the submitted manufacturer's part number marked on the outside of the package.

Individual 250 um coated fibers shall be up-jacketed to 3.0mm using fan-out tubing. This tubing shall contain a 900um Teflon inner tube, aramid yarn strength members, and an outer jacket. The fan-out tubing shall be secured to the cable in an hard epoxy plug transition. Length of the individual legs shall be a minimum of 36 inches with the length difference between the shortest and longest legs of the assembly being no more than 2 inches.

FOC - 1.10 System configuration

Drop & Insert Applications

Signal from the TOC to local controllers, Cameras, and/or Variable Message Signs will be conveyed via the backbone & branch cables in a closed loop configuration. At each controller, the applicable fibers will be routed in & out of the applicable housing via a mid-span access splice point and a pre-terminated drop cable. Only fibers required for the drop & insert shall be cut, no other fibers in the cable shall be cut without the direction of the engineer.

Fibers shall be routed to equipment from the fiber trunk via a drop cable. The drop cable shall have connectors factory-installed and tested. The length of the drop cable shall be determined by the contractor after the traffic signal cabinet, pull boxes, and conduit has been installed to insure proper sizing. Twenty feet (20) of drop cable shall be coiled neatly in the pull box with the splice enclosure to provide slack. The drop cable shall be designed to permit repair to the connector end; if a connector requires replacement, the fiber must be accessible to cut at the back of the connector and a new connector added at that point without special tools or methods. Splice loss at the splice enclosure end shall be $\leq$0.10 dB.

Mechanical splice, if approved, shall be 3M Fibrlok Optical Fiber Splice or approved equal. The splice shall be stored in a splice organizer/tray specifically designed for the mechanical splice used. Fusion splices shall be protected using heat shrink protective sleeves and stored in a splice organizer/tray specifically designed for the protection device.

Point-to-Point Applications

Signal to the local controllers will be conveyed by routing fiber optic cable directly between equipment with an appropriate fiber count cable and be directly terminated with Field installable ST compatible connectors. At the end points, the cable shall be terminated via one of two methods:.

For direct connect applications, the fiber optic cable shall be terminated using a Spider Fan-out Kit. Any substitute termination method must have at a minimum 24" of 3.0mm fan-out material jacketing for fiber protection, provide for central member strain relief, provide for antirotation and pull out. Field installable ST compatible connectors will be terminated on the fan-out and connected directly to the transmission equipment.

For cross connect applications inside controller cabinets, the fiber optic cable shall be terminated using a 900µm fan-out modular design for the fiber count being terminated. The non-metallic fan-out shall attach directly to the buffer tube and transition the 250µm coated fibers into the fan-out tubing. The fan-out shall be housed in a Wall Mount Distribution cabinet equipped with the appropriate number of adapters. The fibers shall be connected to the transmission equipment via ST/ST fiber optic patch cables. This hardware scheme shall also be utilized for wall mount applications.

Fiber Optic Communications

Fiber Optic Data Transceiver

The Transceiver(s) shall be located at the TOC and communicate directly with the traffic controllers in the closed loop system(s). They shall be rack mountable. The fiber optic data transceiver shall be compatible with the internal modem(s) installed internally in each traffic controller. The field unit shall be an approved equivalent of the General Electric S7730DVT-EFC1.

Fiber Optic Rack Mount Enclosure (where required).

The fiber optic rack shall be compatible with the Receiver in center: The field unit shall be an approved equivalent of the General Electric 7730DVR-RFC1 supplied in 501R standalone rack-card enclosure

FOC - 1.11 Fiber Optic Patch Cables (Jumpers)

Any patch cords used for system configuration shall be compatible with fiber types and connectors specified herein. Single-mode patch cords shall be yellow in color and each jacketing material shall conform to the appropriate NEC requirement for the environment in which installed. All cordage shall incorporate a 900um buffered fiber, aramid yarn strength members, and an outer jacket. Patch cords may be simplex or duplex, depending on the application. Single-mode fibers shall be 1.0dB/km @ 1310nm, 0.75dB/km @ 1550.

FOC - 1.12 Fiber Optic Connectors

All connectors used in the communication system shall be ST compatible, ceramic ferrule connectors. Factory terminated connectors shall be heat cured epoxy type with a maximum measured loss of $\leq$0.30 dB; Field installable connectors may be heat cured epoxy or no polish cleave & crimp technology, with a maximum measured loss of $\leq$0.50 dB per mated pair. The operating temperature of all connectors in the system shall be -40C to $\pm$70C with no more than a 0.20dB change across the temperature range.

FOC - 1.13 Fiber Optic Closures

Aerial, Pole Mount, Pedestal, and Hand Hold Environments. OSP Closure for Aerial, Pole Mount, Pedestal, and Hand Hold will incorporate the following features:

The closure shall be capable of accepting up to six cables in a butt splice.

The closure shall be capable of storing up to 90" lengths of expressed buffer tubes.

Assembly shall be accomplished without power supplies, torches, drill kits or any special tools. Reentry shall require no additional materials. Sealing shall be accomplished by enclosing the splices in a polypropylene dome that is clamped together with a stainless steel latch and sealed with an O-ring.

Closure shall be capable of strand mounting with the addition of a strand mounting bracket.

Splice case shall be non-filled (no encapsulate), will prevent water intrusion and shall allow re-entry without any special tools. The closure shall be capable of preventing a 3 meter (10 foot) water head from intruding into the splice compartment for a period of 7 days. Testing of the closure is to be accomplished by the placing of the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Apply continuous pressure to the vessel to maintain a hydrostatic head equivalent to 3 meters on the closure and cable. This process shall be continued for 7 days. Remove the closure, open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure. It is the responsibility of the Contractor to insure that the water immersion test has been performed by the manufacturer or an independent testing laboratory, and the appropriate documentation has been submitted to the city.

Buried-OSP Closure for buried applications will incorporate the following features:

> Splice case must handle up to four cables. A butt adapter, if applicable could be used to increase capacity to eight cables.
>
> Splice case shall be non-filled (no encapsulate), will prevent water intrusion and shall allow re-entry without any special tools. The closure shall be capable of preventing a 3 meter (10 foot) water head from intruding into the splice compartment for a period of 7 days. Testing of the closure is to be accomplished by the placing of the closure into a pressure vessel and filling the vessel with tap water to cover the closure. Apply continuous pressure to the vessel to maintain a hydrostatic head equivalent to 3 meters on the closure and cable. This process shall be continued for 7 days. Remove the closure, open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure. It is the responsibility of the Contractor to insure that the water immersion test has been performed by the manufacturer or an independent testing laboratory, and the appropriate documentation has been submitted to the city.
>
> The closure shall be capable of accommodating splice organizers which accept mechanical, single fiber fusion, or multi fiber splices. The closure

shall have provisions for storing fiber splices and unspliced fiber/buffer tubes. The closure shall hold a minimum or 2 splice trays to a maximum of 15 splice trays with each tray housing up to 24 splices. The closure shall be UL rated.

Closure re-entry and subsequent reassembly shall not require specialized tools or equipment.

For compression testing, the closure shall not deform more than 10% in its largest cross-sectional dimension when subjected to a uniformly distributed load of 1760 Newtons at -18degreeC and ±38degreeC. The test shall be performed after stabilizing at the required temperature for a minimum of two hours. It shall consist of placing an assembled closure between two flat parallel surfaces, with the longest, closure dimension parallel to the surfaces. The weight shall be placed on the upper surface for minimum of 15 minutes. The measurement shall then be taken with the weight in place. It is the responsibility of the Contractor to insure that the compression test has been performed by the manufacturer or an independent testing laboratory, and the appropriate documentation has been submitted to the city.

FOC - 1.14 Fiber Optic Termination Hardware

For cross connect applications inside controller cabinets, the fiber optic cable shall be terminated using a 900µm fan-out modular design for the fiber count being terminated. The nonmetallic fan-out shall attach directly to the buffer tube and transition the 250µm coated fibers into the fan-out tubing. The fan-out shall be housed in a Wall Mount Distribution cabinet equipped with the appropriate number of adapters. The fibers shall be connected to the transmission equipment via ST/ST fiber optic patch cables. This hardware scheme shall also be utilized for wall mount applications.

For rack mount applications, the fiber optic cable shall be terminated using a 900µm fan-out modular design for the fiber count being terminated. The non-metallic fan-out shall attach directly to the buffer tube and transition the 250µm coated fibers into the fan-out tubing. The fan outs shall be housed in a Fiber Distribution Center sized for 50% growth based on the initial installation. Appropriate panels for ST adapters shall be included based on the population of the fiber cable installed. If fusion or mechanical pigtail splicing is used for termination points, a splice housing with appropriate 900um pigtails and splice trays shall be used in conjunction with the Fiber Distribution Center.

FOC - 1.15 Installation

Aerial Installations

All fiber optic components will be installed in accordance with the manufacturer's instructions. All necessary interconnections, services, and adjustments required for a complete and operable data transmission system shall be provided. All pole attachments, service loops, and conduit risers will be placed to minimize the possibility of damage as well as to facilitate future expansion or modernization.

Cable between controllers shall be lashed to a 1/4” EHS messenger with stainless steel lashing wire for aerial installations. The installation will be accomplished in accordance with accepted OSP construction practices. Precautions shall be taken to insure the installation specifications for the cable are not exceeded (tension, minimum bend radius). The cable shall be marked with an orange weatherproof identifying tag at each pole location, with print "Caution, Fiber optic Cable"

The cable shall be installed in continuous runs as indicated on the plans. Splices shall be allowed only at drop points and only those fibers necessary to complete the communication path shall be spliced (mid-span access). All other fibers in the cable(s) shall be left undisturbed; with a minimum of 5 feet of buffer tube coiled inside the closure.

Sufficient slack shall be left at each drop point to enable access of the cable components and splicing to occur on the ground (typical 2 x strand height plus 15 ft) (60 feet). For aerial slack storage at splice points, a radius controlling device, commonly referred to as a SNO-SHOE shall be used for securing resulting cable slack at aerial splice points and shall be mounted directly to the strand.

For aerial cable runs exceeding 6 pole spans between splice points (indicated on the plans), two opposing SNO-SHOES shall be placed on the span 50' apart to provide for a 100' service loop for future drops and for slack for repair and pole relocations.

Underground Installations

Install fiber-optic cable underground in conduit using cable pulling lubricants approved by the fiber-optic cable manufacturer and the Engineer.

Obtain approval of cable pulling lubricant and method of pulling before installing underground fiber-optic cable.

Use a dynamometer (clutch device) so as not to exceed the maximum allowable pulling tension if the cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable pulling forces.

Keep tension on the cable reel and pulling line at the start of each pull. Do not release tension if the pulling operation is halted. Restart the pulling operation by gradually increasing tension until the cable is in motion.

For pulling cable through manholes, junction boxes, and vaults. Feed the cable by manually rotating the reel. Do not pull cable through intermediate junction boxes, handholes, or openings in conduit unless otherwise approved.

For underground installations, the following minimum slack requirements apply, 50 feet at the pull box locations or controller location for midspans, 15' for point to point applications for each cable.

Install communications cable identification markers on each communications cable entering a junction box.

Drop Cable shall be routed to the controller cabinets via conduit risers or underground conduit as illustrated in the plans. The cable entrance shall be sealed to prevent water ingress.

The minimum requirement for fiber protection outside a fiber optic enclosure in ALL cases shall be 3.0mm Fan-out tubing, containing a hollow 900m tube, aramid strength members and an outer jacket, and shall be secured to the cable sheath.

The minimum requirement for fiber protection inside wall mount or rack mount fiber enclosure shall be 900m buffering, intrinsic to the cable in the case of tight buffered fibers, or in the case of 250m coated fibers, a fan-out body & 900m tubing secured to the buffer tube(s).

FOC - 1.16 Testing and Documentation

OTDR TESTING

Prior to the installation, the contractor shall perform on-site on the reel testing. The contractor is required to test all fibers in each reel of cable prior to installation. This testing is for both continuity and attenuation. The tests shall be conducted at 1310nm for single mode fibers. The testing shall be performed using an Optical Time Domain Reflectometer (OTDR) via a "pigtail" splice. The resultant OTDR trace(s) shall reflect overall length and attenuation expressed in db/km. All test results shall be within ±3.0% of factory supplied attenuation measurements for single mode fibers. Testing shall be done in one direction only. Hard copy or disk based (with applicable software) OTDR traces for the testing shall be supplied to the City by the contractor prior to installation of cables. The contractor may opt to accept factory results and install cable at his own risk. In either case, On-the-reel test results or factory measurements shall be provided to the city for each cable installed.

Following installation, each section of the installed cable shall be tested for continuity and attenuation as indicated above. The traces shall demonstrate that no change in transmission characteristics has occurred during installation and that any splices meet the requirements herein. This testing can be done in conjunction with the ETE testing described below. The traces shall be included in the documentation package provided at the conclusion of the contract.

ATTENUATION TESTING

Only connectorized spans will be tested for final End-to-End attenuation (power loss). The testing shall be performed at 1310 nm and 1550 nm for single-mode fibers. The testing shall be conducted using "hand-held" optical test sets and shall be conducted using a two jumper reference. The testing shall be in one direction only. The results shall be tabulated and be included in the documentation package provided at the conclusion of the contract. Overall loss for each link shall not exceed the cumulative specified losses of the components in the link.(EXAMPLE, @850nm, a 1 km link with 2 splices and a connector on each end shall not exceed:

5.0dB((3.5dB±.25dB±.25dB±.5dB±.5dB))

TESTING OF CONTINUOUS FIBER OPTIC CABLE

The fibers in this installation shall be tested for final End-To-End attenuation (power loss). The overall loss for this link shall not exceed the manufacturer’s specifications. The fibers are being installed for future use when demanded and must be operable at this time.

At the conclusion of the contract, 2 copies of system documentation package shall be provided. It shall include at a minimum:

A. Post installation OTDR traces for each fiber.
B. End-to-End Attenuation measurement for each fiber.
C. A splice plan showing the location and configuration of any splices in the system as well as how the transmission scheme is set up.
D. Reference manuals for equipment provided.

ITS DEVICE CONTROL CABINET

ITS - CAB - 1.0 Description.

All construction, materials, equipment, workmanship and installation procedures shall comply with the T.D.O.T. Standard Specifications for Road and Bridge Construction, March 1, 1995 (as amended) Section 730.01 et al, and with these current standards and specifications of the City of Franklin.

ITS - CAB - 1.1 Materials.

Material, equipment, and hardware furnished under this section must be pre-approved by the Engineer.

The contractor shall provide a Type B Model 336A cabinet specifically wired for either CCTV, DMS, WMS or PCS, dependent on the application for the installation.

ITS - CAB - 1.2 Functional Requirements

The cabinets shall be provided with fully wired back and side panels with all necessary terminal boards, wiring harnesses, connectors and attachment hardware for each cabinet location. All equipment shall be shelf mounted. All terminals and panel facilities shall be placed on the lower portion of the cabinet walls below the shelves.

The Contractor shall submit a cabinet layout for each installation for review by the Engineer. Only cabinets with approved layouts will be accepted by the City of Franklin. Each field cabinet shall, as a minimum, be supplied with the following:

- Fan and Thermostat
- Left Side Power Distribution Panel
- Air Filter
- Adjustable Shelves (1-4 as required)
- Back Panel
- Right Side Panel
- Locking Mechanism
- Lock
- Ground Bus (2)
- Surge Protection (for Solid State Equipment)
- Terminal Blocks
- Duplex Power Outlets (GFI protected)
- Drawer that opens and slides out for placement of notebook computer
- All necessary installation and mounting hardware.

a. ITS – CAB – CCTV Cabinet

The contractor shall provide and install all equipment, hardware and software to provide for functional camera installation. The camera installation shall provide an operating camera with equipment ready for future fiber optic communications with the City of Franklin's Transportation Operations Center. The equipment consists of a transmitter in the cabinet (General Electric Co.; Model # S7730DVT-EFCI) and the accompanying receiver for the Transportation Operations Center (General Electric Co.; Model # SS7730DVR-RFCI).

ITS - CAB - 1.3 Construction Methods.

The contractor shall install the CCTV pole standard per the T.D.O.T. Standard Specifications, and pole manufacturer's design standards.

The cabinet will be secured using steel banding.

The pole base will provide three (3) 2-inch, non-metallic (High Impact Schedule 80 PVC) conduits into the interior of the pole. One of the conduits will contain the metered power service lines. One conduit will contain the communications cable (Fiber optic or hardwire). The remaining conduit will be a spare with a pull rope installed between the main pull box and the pole foundation.

One 2-inch conduit nipple will connect the cabinet with the interior of the pole.

Metered power leads, data cables and communications cables shall be run on the interior of the pole.

Handholes shall be provided near the base of poles and near the device location for access to install and maintain the data leads. Strain relief J-hooks will be provided on the interior of the pole at the device location handhole.

Cabinet shall be mounted 48" above finish grade.

ITS - CAB - 1.4 Method of Measurement.

In accordance with the T.D.O.T. Standard Section 730 et al.

CCTV, POLE & LOWERING DEVICE

CCTV - 1.0 Description.

All construction, materials, equipment, workmanship and installation procedures shall comply with the T.D.O.T. Standard Specifications for Road and Bridge Construction, March 1, 1995 (as amended) Section 730.01 et al, and with these current standards and specifications of the City of Franklin.

CCTV - 1.1 Materials.

Material, equipment, and hardware furnished under this section must be pre-approved by the Engineer.

The contractor shall provide a CCTV PTZ camera, control and communications hardware and enclosure, pressurized dome housing and mounting apparatus equivalent to the Vicon Dome Camera (Model # SVFT-PR23). The contractor shall pressurize the camera dome and provide the City of Franklin a certification document warranting that work.

In addition, the contractor shall provide a galvanized metal pole standard with a length of fifty (50) feet. The pole standard shall be designed according to AASHTO Standards and Specifications For Structural Supports For Highway Signs, Luminaires, and Traffic Signals (Current Edition, et al). The pole standards shall be designed for a wind velocity of ninety (90) miles per hour.

The contractor shall also provide a lowering device compatible with the existing City of Franklin Vicon Surveyor VFT series equipment.

Camera Lowering Device Requirements for 50' poles

Basic Configuration

The work under this item specifies the additional requirements for the 50 foot poles which should be equipped with the Camera Lowering Device (CLD). The Camera Lowering Device shall be safely operable by one trained technician working alone, to lower the Camera Assembly to ground level for maintenance as necessary and return the Camera Assembly to the pole top mounting and secure it in place, eliminating the need for access by a bucket truck. The camera lowering device shall be installed at camera sites as indicated on the plans. Weatherproof connectors (camera to the lowering device) shall allow for adaptation of the camera and the dome type housing for lowering and hoisting. Lifting and lowering shall be done with a motorized gear box (winch). The CLD should be a stand-alone device mounted on a camera pole to be supplied by the Contractor and included in the cost of the 50' pole. An integrated CLD with pole assembly may be procured provided it meets all specifications.

General

The Contractor shall design the required pole mounting adapters, brackets and mounting hardware, including extensions and cable entry to the camera mounting pole to accommodate the dome enclosure with pan/tilt unit and pole combination. The pole mounting adapter shall be electrically bonded to the pole. The pan and tilt unit shall be electrically bonded to the mounting adapter. An individual Camera Lowering Device shall be furnished and installed at each CCTV site designed to support and lower a standard closed circuit television camera, lens, housing, PT mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. This Camera Lowering Device shall consist of an arm mounted suspension contact unit attached to the galvanized steel pole at locations as shown on the Plans. The Camera Lowering Device shall include a tracking guide system permitting the moveable portion of the system to align in the same position every time the system is operated thereby eliminating the need to re-orientate the camera. The electrical / signal connector shall mate without any degradation of performance due to vibration or movement during operation. The cables for the Camera Lowering Device shall not come into contact with any other cables inside the pole.

The entire device, complete with the camera, shall be tested by an independent laboratory experienced in structural, mechanical and electrical testing. It shall be shown to withstand wind forces of greater than 90 mph with a 1.3 gust factor. Certified and dated test reports from the testing facility shall be submitted to the Engineer within ten (10) days after the testing for review and approval.

All Contractor designs, testing results and shop drawings of the camera mounting, lowering device and structural design shall be in compliance with the Contract Documents and Plans and submitted to the Engineer for review and approval ninety (90) days after the Notice to Proceed. The Contractor shall arrange for a factory representative to assist the Contractor with the assembly and testing of the first Camera Lowering Device onto the pole assembly. Copies of written installation and operating instructions shall be furnished to the Engineer as required by the Contract Documents.

All external components of the Camera Lowering Device shall be made of corrosion resistant materials, anodized, galvanized, or otherwise protected from the environment and dissimilar metals by industry accepted coatings to withstand exposure to a corrosive environment. All pulleys for the camera lowering device and portable lowering tool shall have sealed, and self lubricated bearings. At the discretion of the Engineer, an integrated CLD with pole assembly may be procured.

Suspension Unit
The Contractor shall design the required pole mounting adapters, brackets and mounting hardware. The Camera Lowering Device shall have a minimum load capacity 200 pounds with a 10 to 1 safety factor. The enclosure receptacle and camera enclosure shall incorporate a mating device. The mating device shall have a minimum of 2 latching devices. These latching devices shall securely hold the camera housing and its control equipment free of vibration or motion between the enclosure receptacle and camera enclosure. The latching devices shall lock and unlock by alternately raising and lowering the camera enclosure. When the camera enclosure is latched, all weight shall be removed from the lowering cable. The enclosure receptacle and camera enclosure shall have a heavy-duty tracking guide. The tracking guide and latching devices shall lock the camera enclosure in the same position each time.

Sufficient electrical contacts shall be provided to support all camera functions. The electrical contacts shall be gold coated to prevent corrosion. In addition, replaceable gaskets shall be provided to seal from moisture and dust the electrical contacts and latching devices.

The Camera Lowering Device shall be designed to preclude the lifting cable from contacting the power or video cabling. The only cable permitted to move within the pole or lowering device during lowering or raising shall be the stainless steel lowering cable. All other cables shall remain stable and secure during lowering and raising.

The Camera Lowering Device shall support the Camera Assembly a minimum of 20" from the pole. The Camera Lowering Device shall be designed to permit a ±3 degree of horizontal adjustment for leveling the dome enclosure. The lowering cable shall be a minimum 5/32" diameter stainless steel aircraft cable with a minimum breaking strength of 2400 pounds.

Weights and/or counterweights shall be provided as necessary to assure that the alignment pin and connectors are proper for the camera support to be raised into position without binding and that sufficient weight is present on the camera and it's control components that it can be lowered properly.

Portable Camera Lowering Device Tool

The Contractor shall furnish and test one Portable Lowering Tool capable of being operated by a hand winch and an electric drill motor, which is fully compatible with the Camera Lowering Device and the Steel Camera Pole and meets the following requirements:

- The Portable Lowering Tool shall be one recommended by the manufacturer of the Camera Lowering Device.
- The Portable Lowering Tool shall have a minimum load capacity of 200 pounds with a 10 to 1 safety factor.
- The tool shall consist of a lightweight metal frame and winch assembly with cable, a quick release cable connector, an adjustable safety clutch and a variable speed industrial duty electric drill motor.
- This tool shall be compatible with the hand hole of the pole and the Camera Lowering Device inside the hand hole.
- When attached to the hand hole, the tool will support itself and the load assuring lowering operations and provide a means to prevent freewheeling when loaded.
- The Portable Lowering Tool shall be delivered to the Engineer upon project completion.
- The Portable Lowering Tool shall have a reduction gear to reduce the manual effort required to operate the lifting mechanism.
- The Portable Lowering Tool shall be provided with an adapter for operating the lowering device by a portable drill using a clutch mechanism.

- The Portable Lowering Tool shall be equipped with a positive locking mechanism to secure the cable reel during raising and lowering operations.

CCTV - 1.2 Construction Methods.

The contractor shall install the CCTV pole standard per the T.D.O.T. Standard Specifications, and pole manufacturer's design standards.

The CCTV camera shall be installed per the Vicon Installation and Operation Manual, (Part # 8009-8134-00-00) in the "outdoor pendant" configuration.

The CCTV dome housing shall be installed per the Vicon Installation and Operation Manual, (Part # 8009-8004-03-00) in the "pipe mount" method.

The CCTV control and communications hardware and enclosure shall be wired and installed per the City of Franklin Standard Detail 27, and the Vicon Installation and Operations Manuals indicated above.

CCTV - 1.3 Method of Measurement.

In accordance with the T.D.O.T. Standard Section 730 et al.

DYNAMIC MESSAGE SIGNS

DMS - 1.0 Description.

The contractor shall provide and install Dynamic Message Signs (DMS). The signs shall be fabricated according to the City of Franklin standards for DMS.

DMS - 1.1 Materials.

Material, equipment, and hardware furnished under this section must be pre-approved by the Engineer.

DMS - 1.2 Construction Methods.

In accordance with the T.D.O.T. Standard Section 730 et al.

DMS - 1.3 Method of Measurement.

In accordance with the T.D.O.T. Standard Section 730 et al.

WEATHER MONITORING STATIONS

WMS - 1.0 Description.

The contractor shall provide and install Weather Monitoring Stations (WMS). The stations shall be fabricated according to the City of Franklin standards for WMS.

WMS - 1.1 Materials.

Material, equipment, and hardware furnished under this section must be pre-approved by the Engineer.

WMS - 1.2 Construction Methods.

In accordance with the T.D.O.T. Standard Section 730 et al.

WMS - 1.3 Method of Measurement.

In accordance with the T.D.O.T. Standard Section 730 et al.

PERMANENT COUNT STATIONS

PCS - 1.0 Description.

The contractor shall provide and install Permanent Count Stations (PCS). The stations shall be fabricated according to the City of Franklin standards for PCS.

PCS - 1.1 Materials.

Material, equipment, and hardware furnished under this section must be pre-approved by the Engineer.

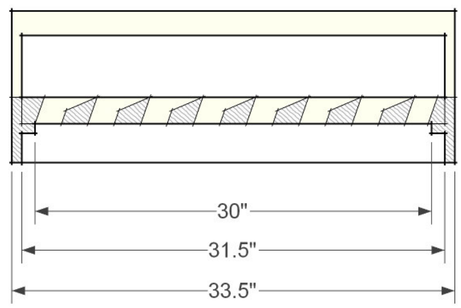
PCS - 1.2 Construction Methods.

In accordance with the T.D.O.T. Standard Section 730 et al.

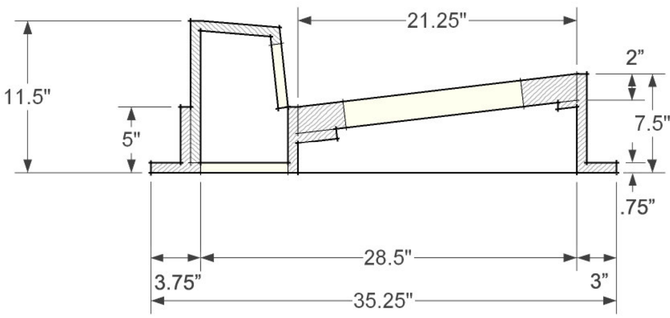
PCS - 1.3 Method of Measurement.

In accordance with the T.D.O.T. Standard Section 730 et al.

No. 3300-V



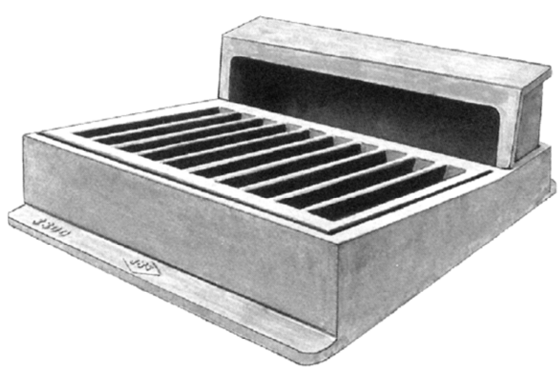
Front View
NTS



Side View
NTS

No. 3300-V

Frame . . . . 270 lbs.
Grate . . . . 190 lbs.
Curb Box . . . . 142 lbs.
Total . . . . 602 lbs.



Isometric View

Notes:

1) John Bouchard No. 3300-V or City of Franklin approved equivalent.

2) Double inlets are required at all street low points where street grade distances exceed 100' in either direction

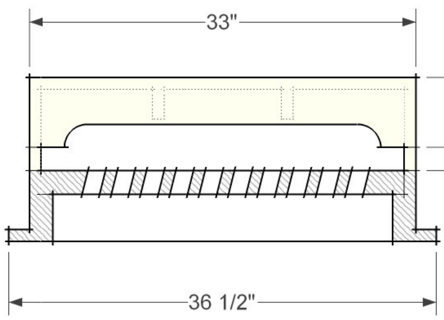
Single Drainage Inlet w/ Vane Grate for Curb & Gutter

City of Franklin
Engineering Department

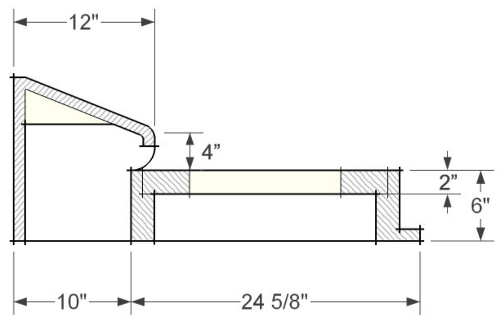
Date: 4/27/06

Std Dwg No:
SD-01A

No. 3104-V



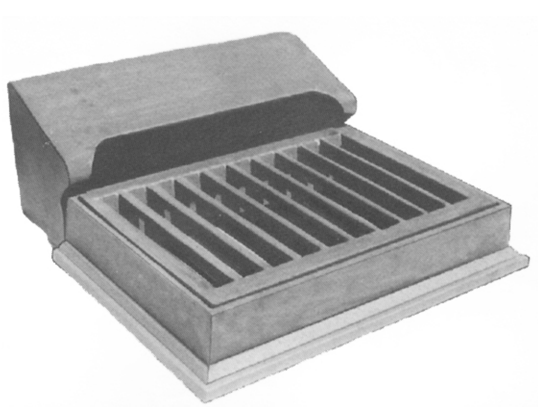
Front View
NTS



Side View
NTS

No. 3103-V

Frame . . . . 285 lbs.
Grate . . . . 190 lbs.
Curb Box . . . . 200 lbs.
Total . . . . 675 lbs.



Isometric View

Notes:

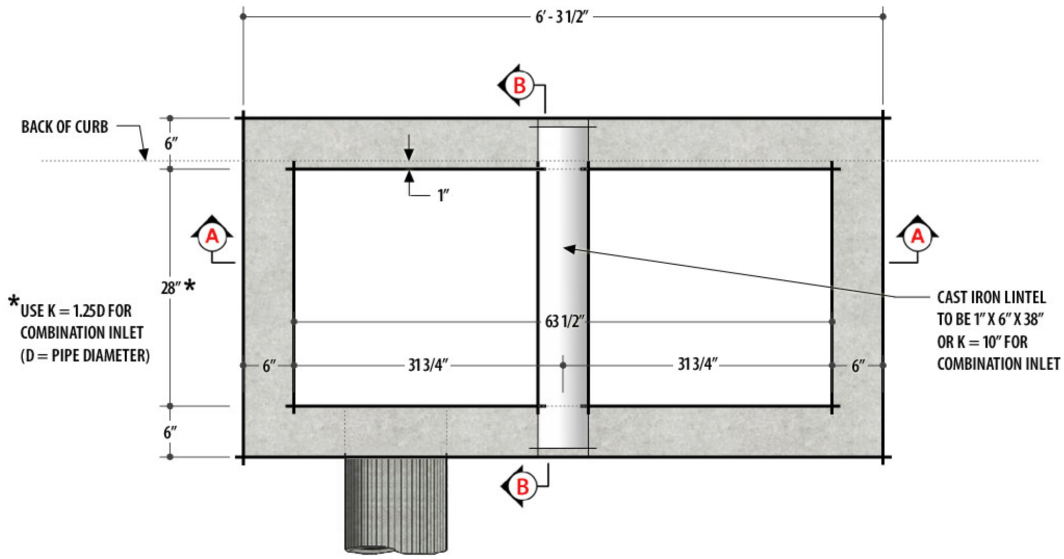
1) John Bouchard No. 3104-V or City of Franklin approved equivalent.
2) Double inlets are required at all street low points where street grade distances exceed 100’ in either direction

Single Drainage Inlet w/ Vane Grate for Extruded Curb Section

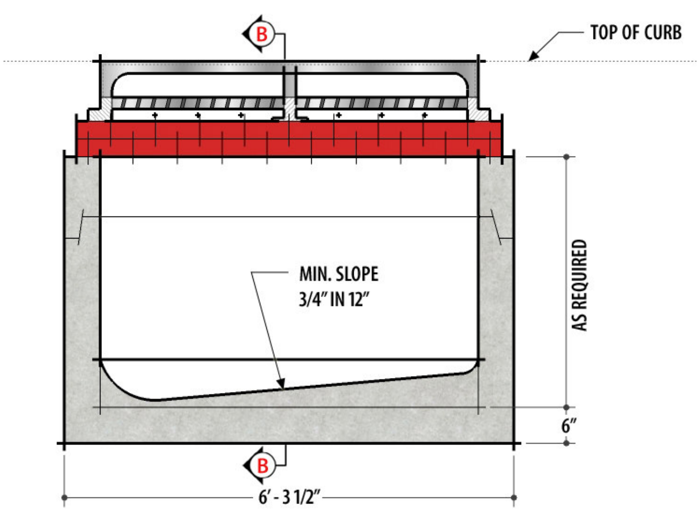
City of Franklin Engineering Department

Date: 4/27/06

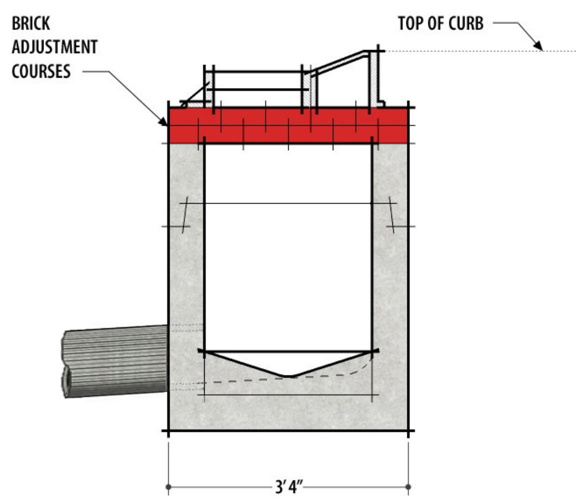
Std Dwg No:
SD-01B



Plan View
NTS



Section A-A
NTS



Section B-B
NTS

Pre-Cast Double Catch Basin

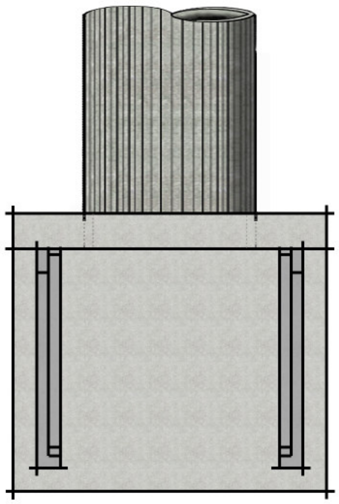
City of Franklin
Engineering Department

Date: 2/22/06	Std Dwg No: **SD-02**

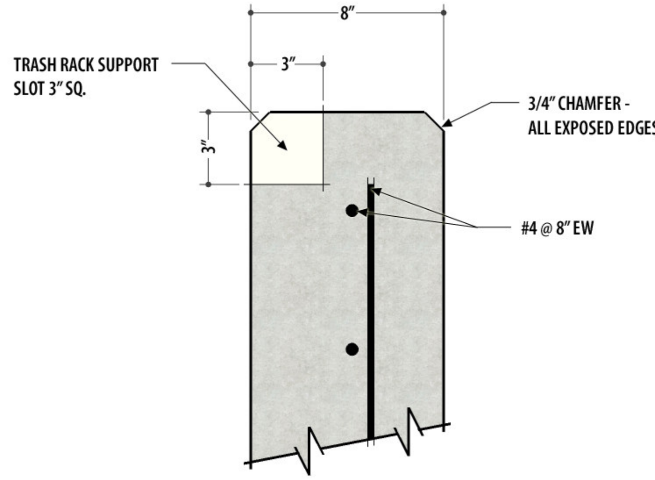
Notes:

1) **Sidewalk section- 3000 psi**
2) **30" Curb and Gutter section- 3500 psi**
3) **This inlet may be used where excessive stormwater runoff is encountered or where large pipes are required.**

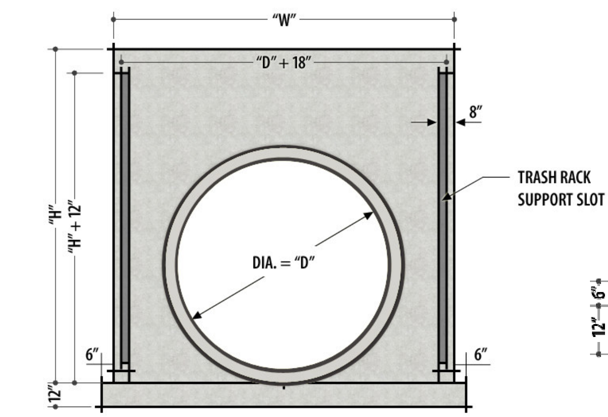
Curb Opening Inlet (Alabama Inlet)	
City of Franklin Engineering Department	
Date: 7/03/07	Std Dwg No: SD-03



Top
NTS

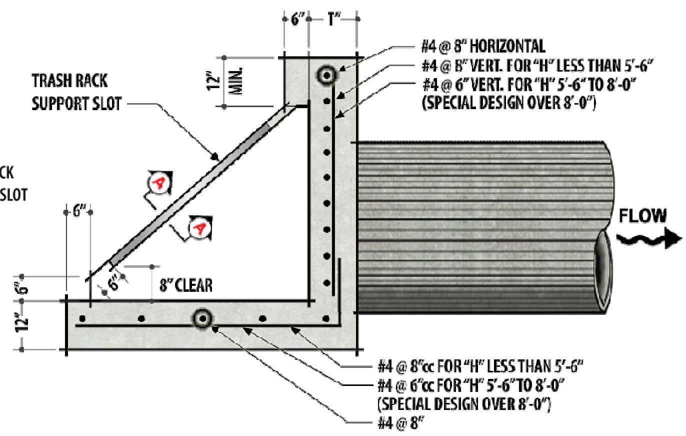


Section A-A
NTS

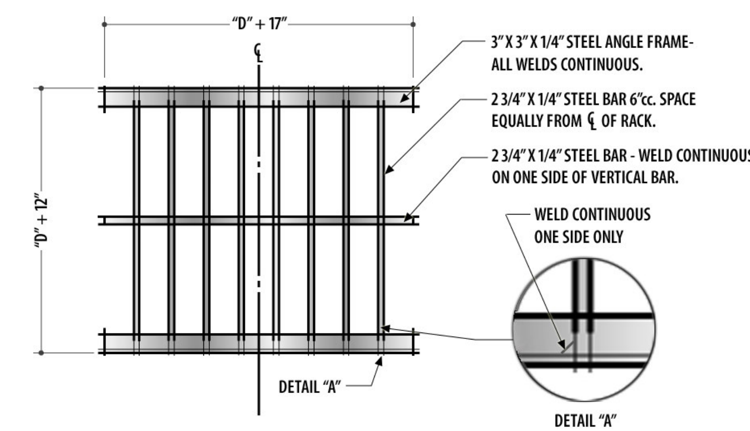


SAFETY RACK HEADWALL REQ'D AT INLET END ONLY FOR PIPE DIAMETER ("D") OF 24" OR LARGER

Front
NTS



Side View
NTS



AFTER FABRICATION, PAINT WITH TWO COATS COAL TAR EPOXY AS APPROVED BY_________________OR GALVANIZE
(_____ OZ. PER SQUARE FOOT)

Safety Rack Detail
NTS

Notes:

1) "T"= 8" for "H"= 5'-6" or less, & 12" for "H" more than 5'-6".

2) "D"= normal pipe diameter.

3) "W"= "D" + 12'- 4"

4) "H"= "D" + 12'- 0" This is minimum, actual "H" to be as req'd by job site conditions, if "H" exceeds 8", special structural design is req'd.

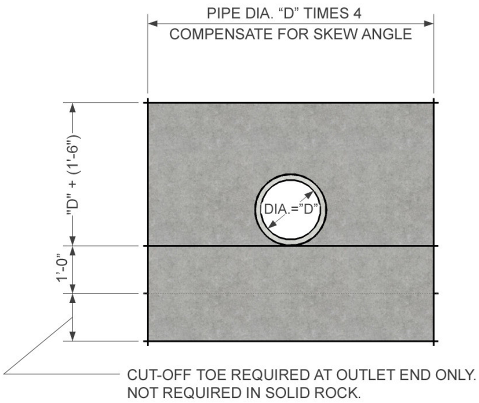
End Wall w/ Safety Grate

To Be Used Where Speed Limits Are > 30 M.P.H.

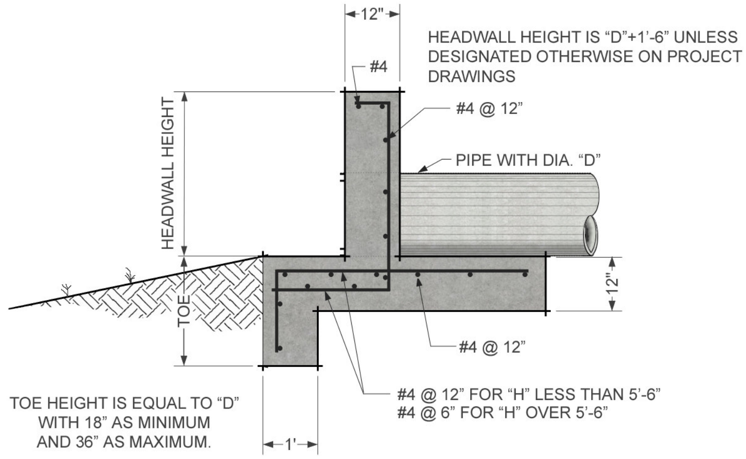
City of Franklin
Engineering Department

Date: 2/22/06

Std Dwg No:
SD-04



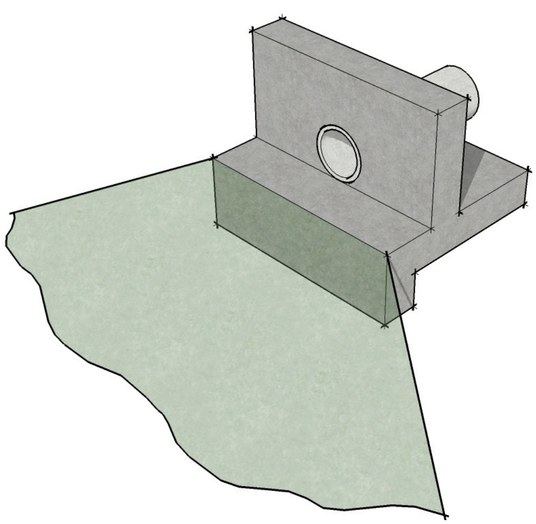
Front View
NTS



Side View
NTS

Concrete: 4000 PSI; Minimum of 5.5 Bags of Cement Per Cubic Yard; Cement ASTM C-150, Type I; Sand ASTM C-33; Crushed Stone ASTM C-33 (Size 57); 5% Air Entrainment, Master Builders MB-VR, or Approved Equal.

Reinforcing Steel: ASTM A615, Grade 60



Isometric View

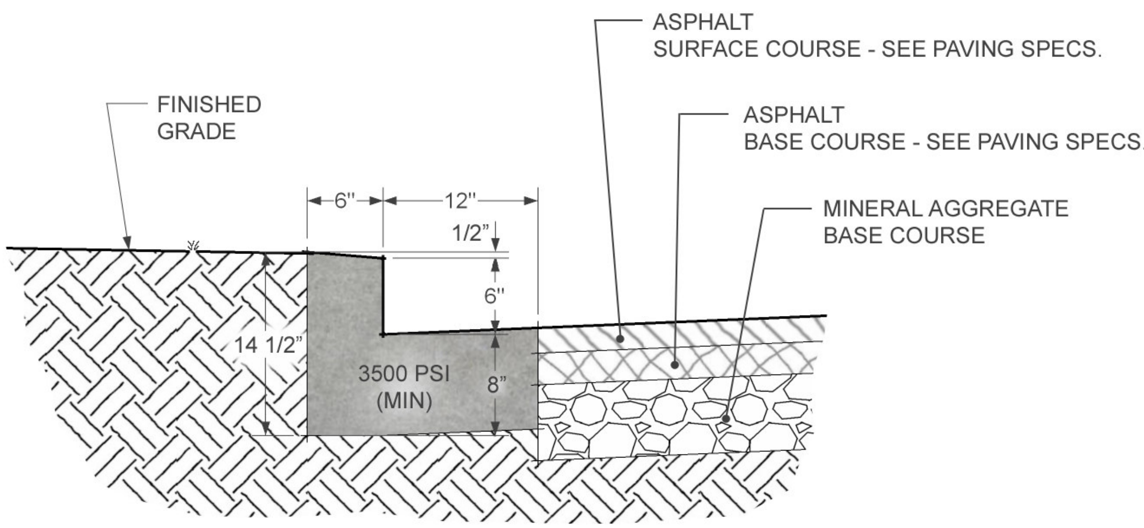
Notes:

Reinforced Concrete Endwall

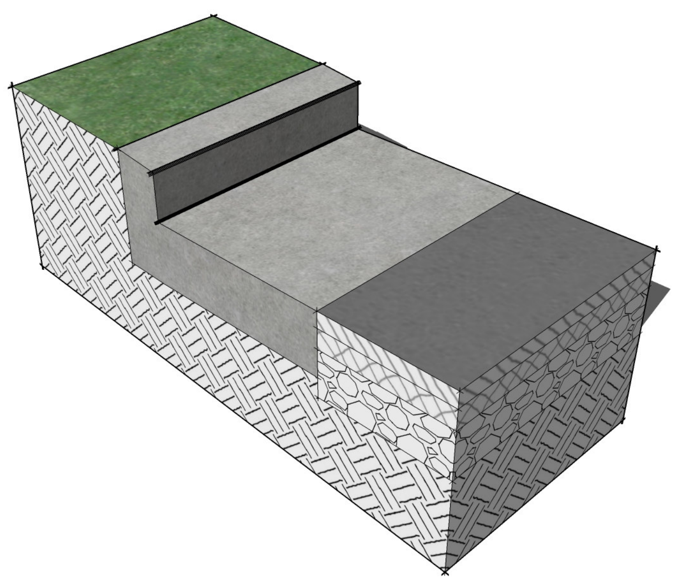
City of Franklin Engineering Department

Date: 4/27/06

Std Dwg No:
SD-05



18" Side View
NTS



Isometric View
NTS

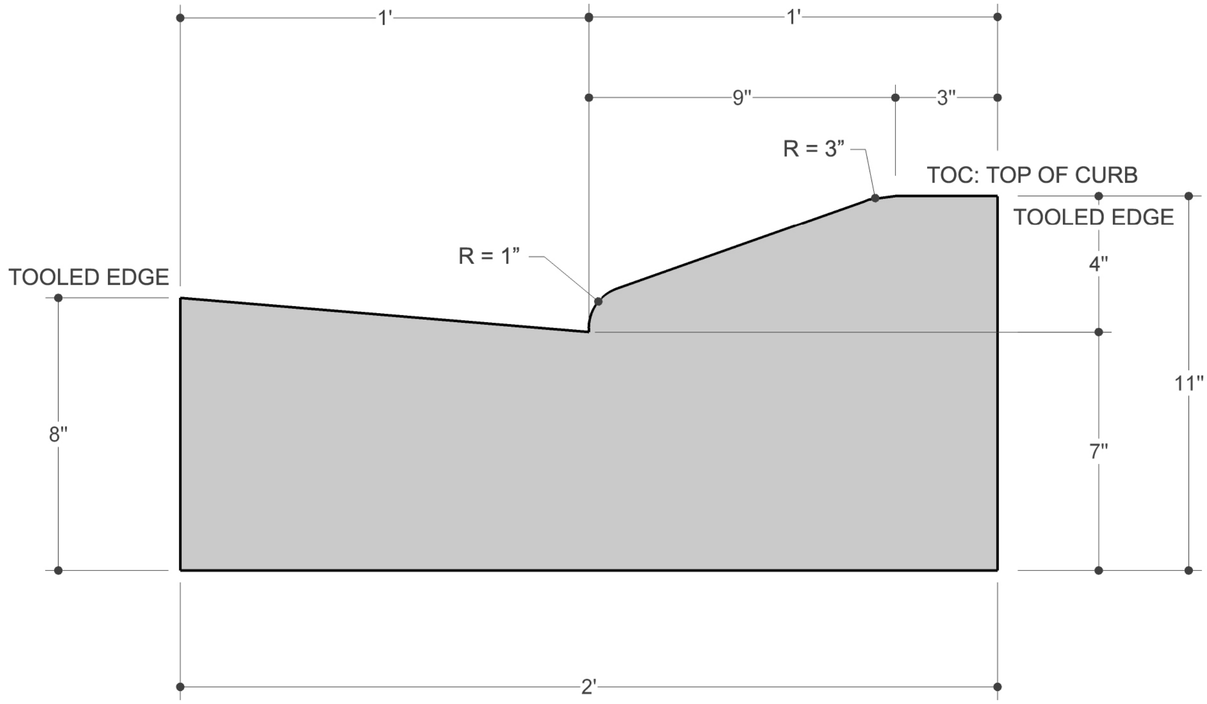
Notes:
Use of 18" curb and gutter section shall not be used unless an 18-inch vane grate to match the gutter width is submitted for approval by the City Engineer.

18" Curb & Gutter Section

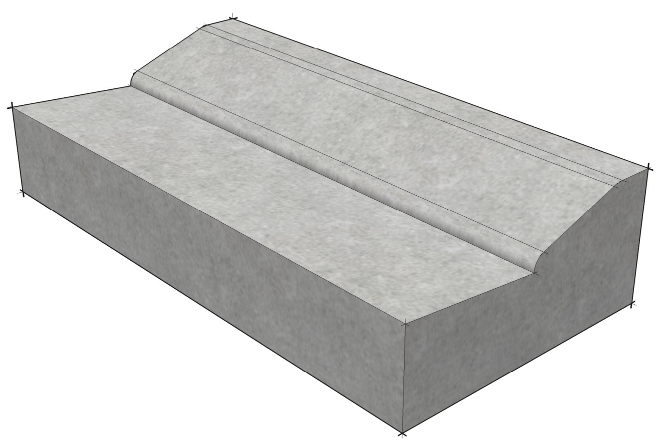
City of Franklin
Engineering Department

Date: 7/03/07

Std Dwg No:
SD-06A



Cross-Sectional View
NTS



Isometric View

Notes:

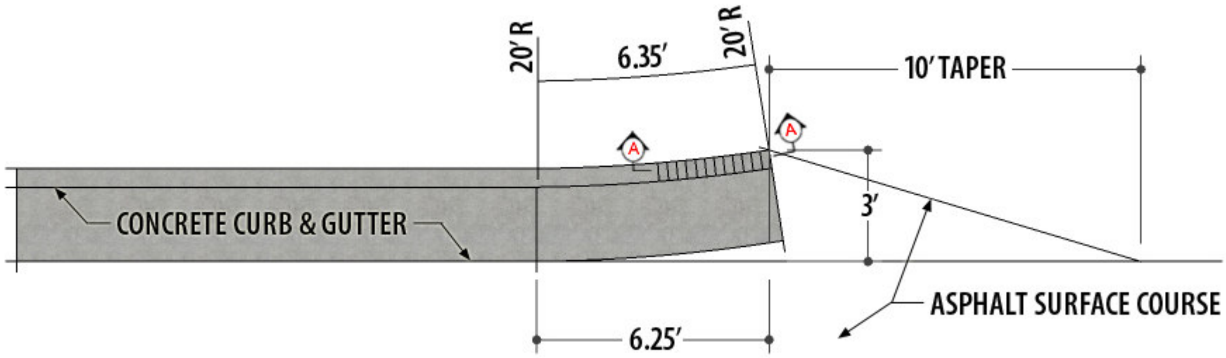
Adopted from the City of Murfreesboro, TN

Rollover Curb &

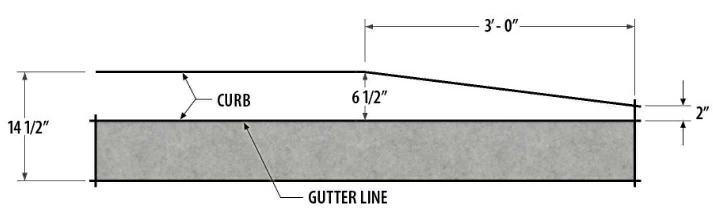
City of Franklin
Engineering Department

Date: 2/22/06

Std Dwg No:
SD-09



PLAN- Curb & Gutter
End Flare & Transition
NTS



Section A-A
NTS

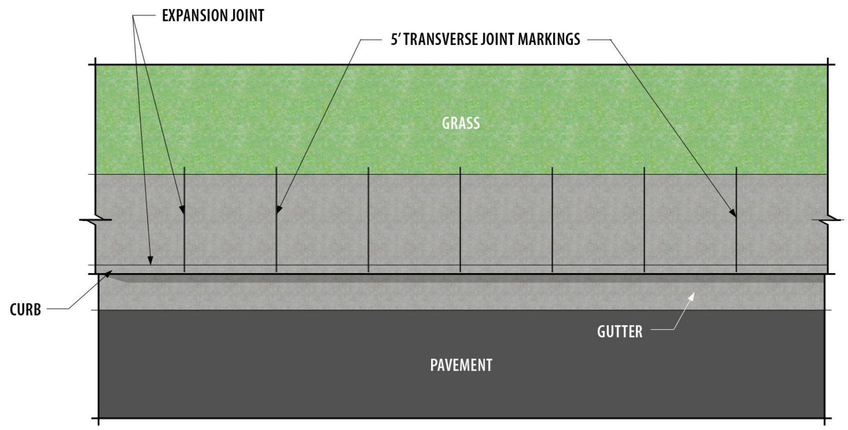
Notes:

Curb & Gutter
End Flare &

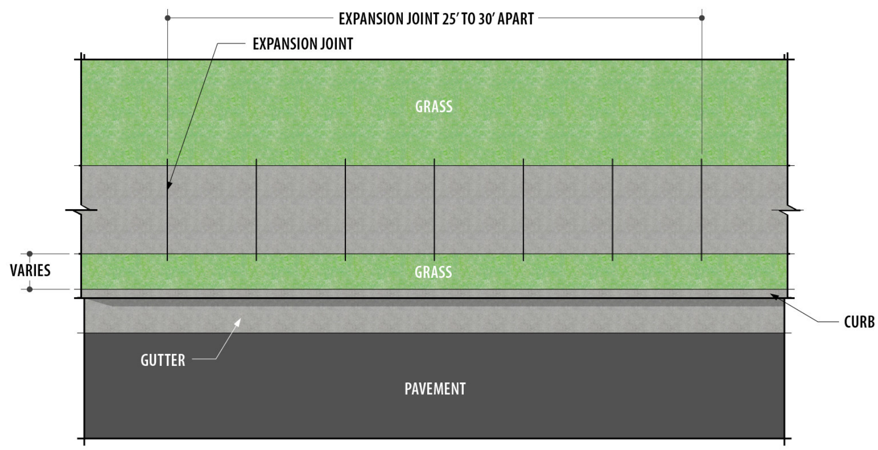
City of Franklin
Engineering Department

Date: 2/22/06

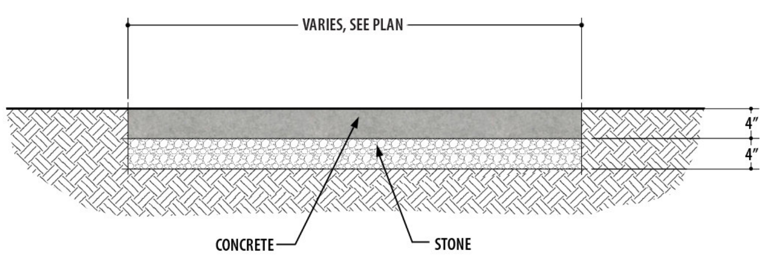
Std Dwg No:
SD-10



5' Sidewalk Built To Curb
NTS



5' Sidewalk With Grass Strip
NTS



Typical Section
NTS

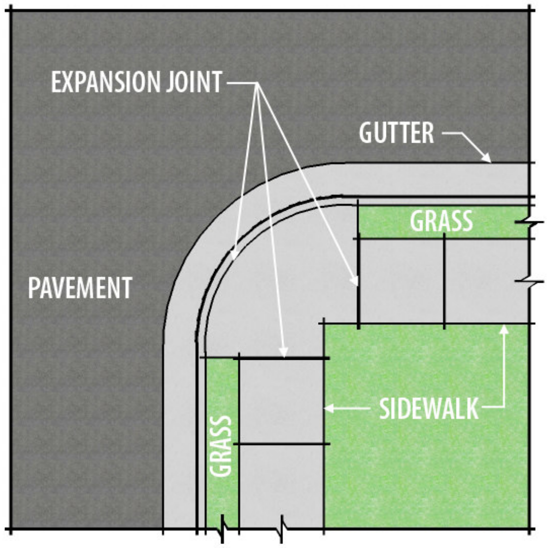
Notes:

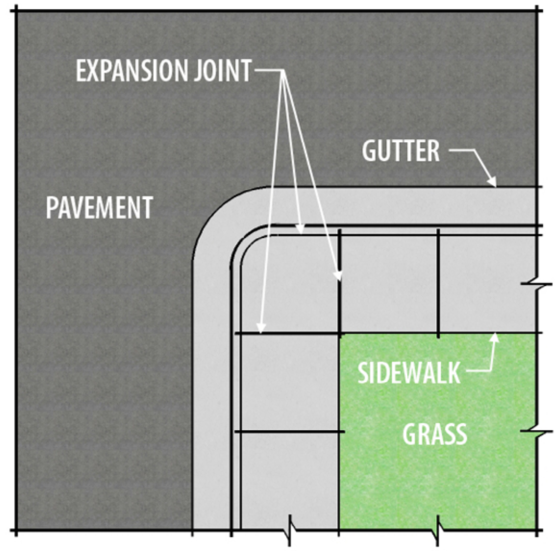
1) 3500 PSI Concrete for Sidewalk.
2) Also see SD-11B for Expansion Joint Details.
3) Root Barriers Required on Both Sides of Grass Strip Around Trees.

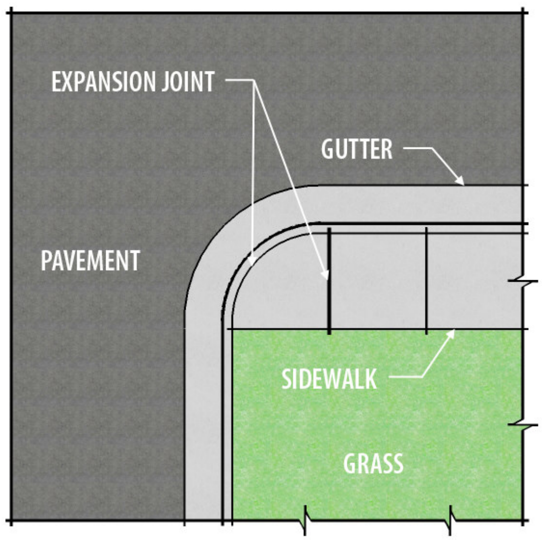
Typical Sidewalk

City of Franklin
Engineering Department

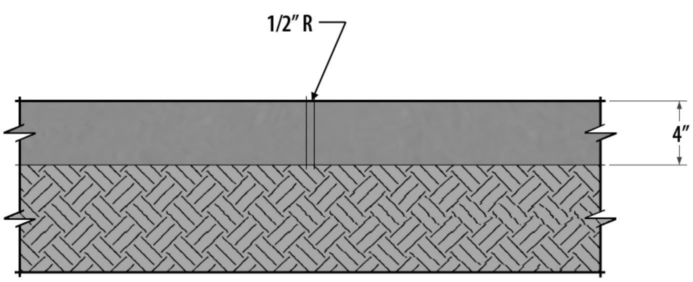
Date: 2/22/06	Std Dwg No: SD-11A







Expansion Joint
NTS



NOTE: 1" JOINTS TO BE PLACED WHERE THE SIDEWALK IS IN CONTACT WITH CIRCULAR CURB, BUILDINGS AND RETAINING WALLS. 1/2" JOINTS TO BE USED AT OTHER LOCATIONS.

ONE LONGITUDINAL JOINT MARKING REQUIRED ON SIDEWALK OVER 5' IN WIDTH TO LESS THAN 9'. TWO LONGITUDINAL JOINTS FOR SIDEWALK 10' TO 12'.

Detail of Expansion Joint
NTS

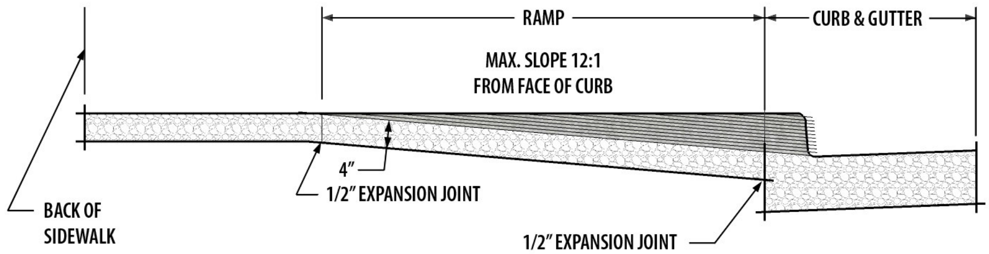
Notes:

Also see SD-11A for Typical Sidewalk Details

Typical Sidewalk Expansion Joint

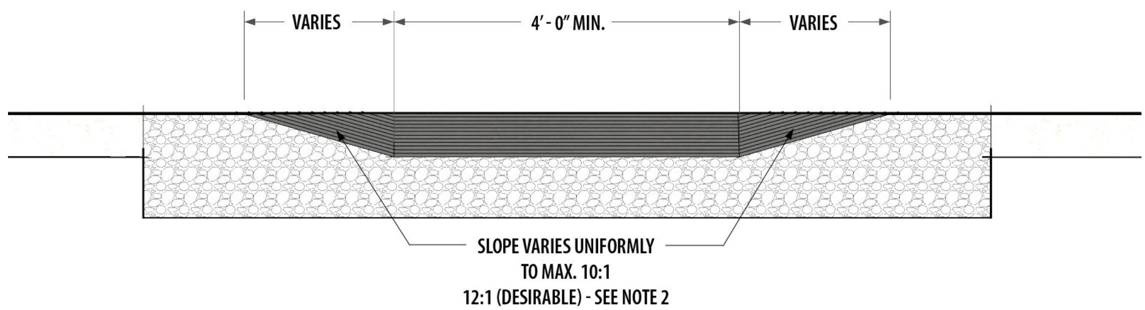
City of Franklin
Engineering Department

Date: 2/22/06	Std Dwg No: SD-11B

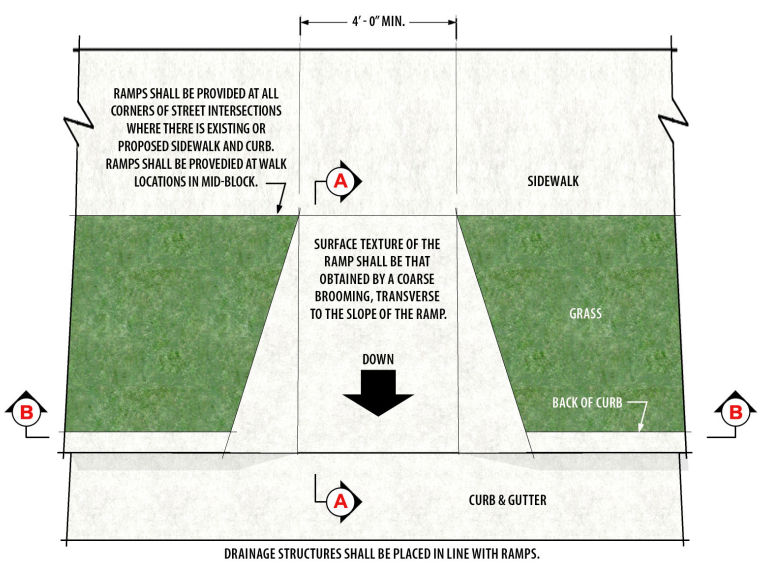


CARE SHALL BE TAKEN TO ASSURE A UNIFORM GRADE ON THE RAMP, FREE OF SAGS AND SHORT GRADE CHANGES.
THE NORMAL GUTTER LINE PROFILE SHALL BE MAINTAINED THROUGH THE AREA OF THE RAMP.

Section A-A
NTS



Section B-B
NTS



Detail "A"
NTS

Notes:

1) Details shown on this plan apply to all new construction or reconstruction of streets, curbs, or sidewalks.

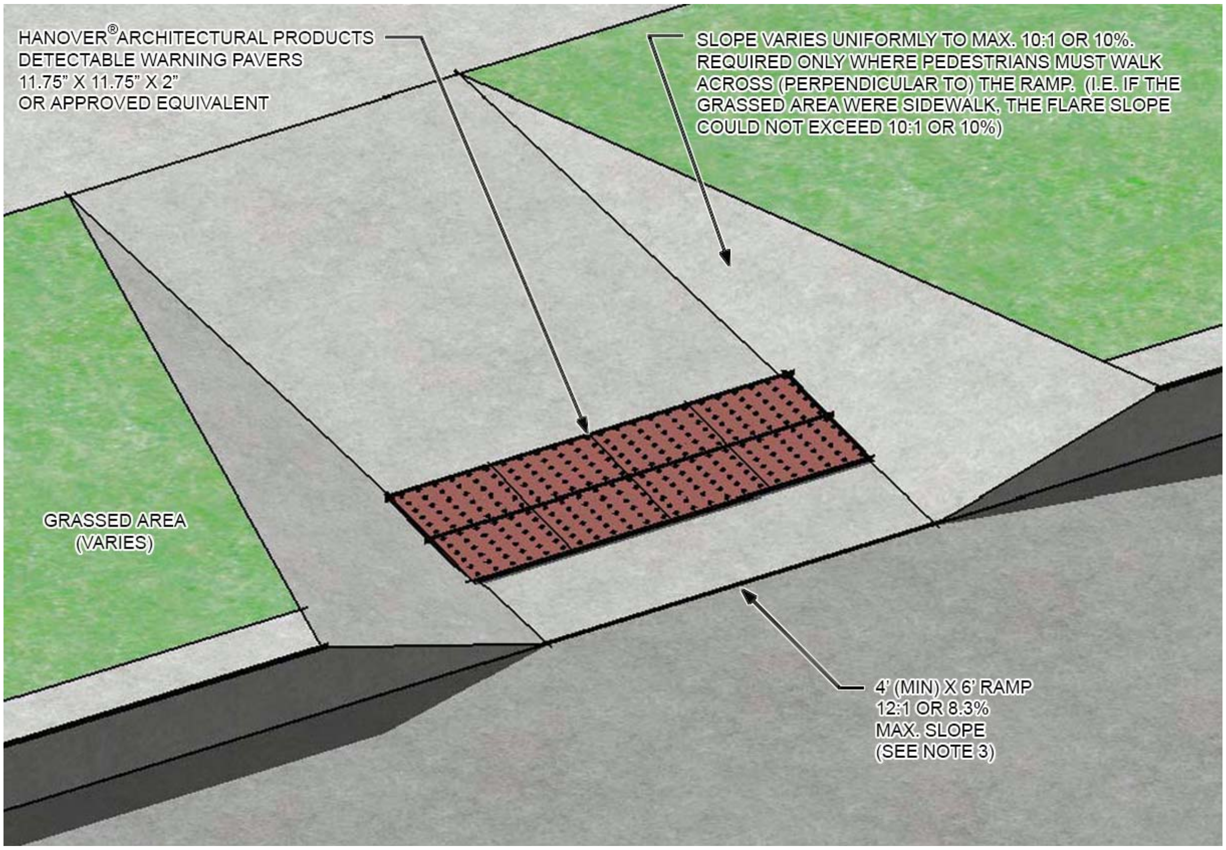
2) Desirable slope to be used unless otherwise directed by the Street Department.

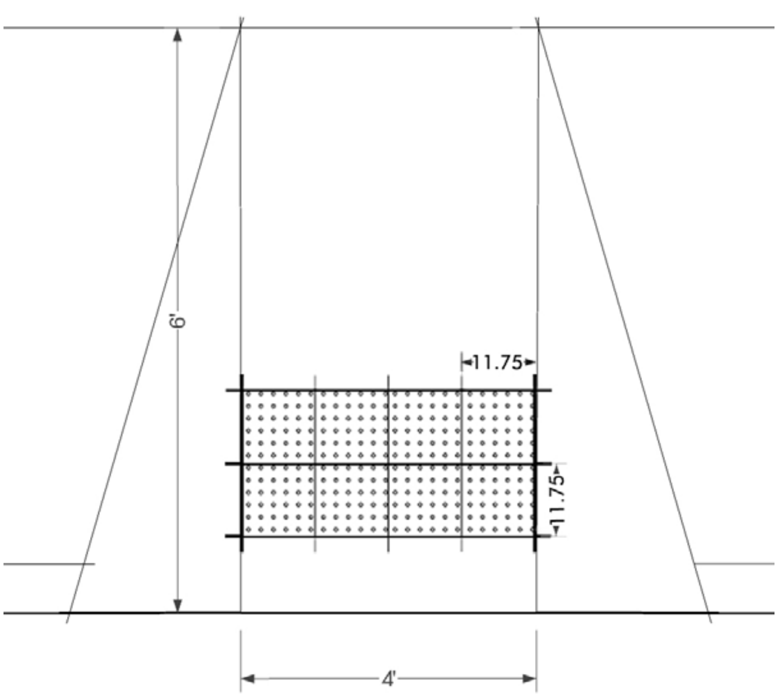
3) Minimum Landing at Top of Ramp is 5'

Handicap Ramp

City of Franklin
Engineering Department

Date: 7/03/07	Std Dwg No: **SD-12A**





Top View
NTS

Notes:

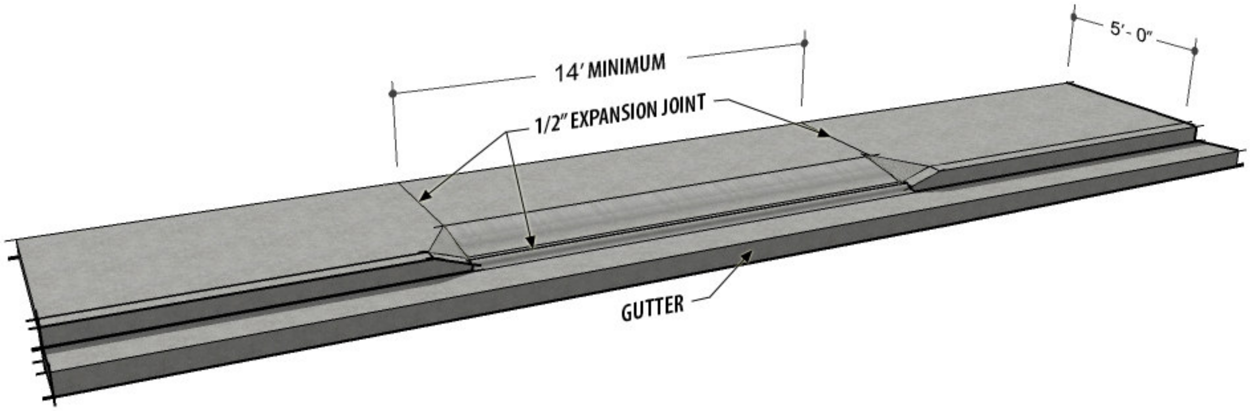
1) Install Pavers Per Manufacturer's Specifications.
2) A Variation of the Ramp May Be Used in Certain Circumstances But Must Comply with North Carolina Accessibility Code requirements.
3) For Corner or Diagonal Ramps, the Minimum Ramp Width Shall Be 4' (48").

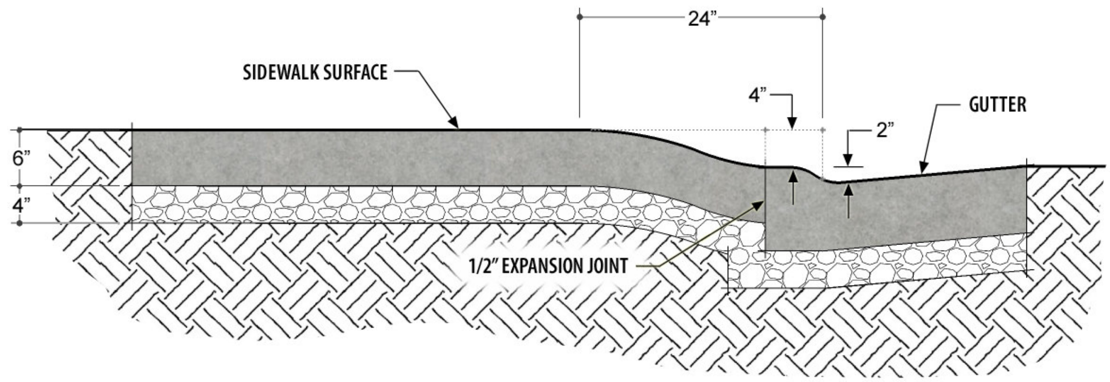
Handicap Ramp with Detectable Warning

City of Franklin
Engineering Department

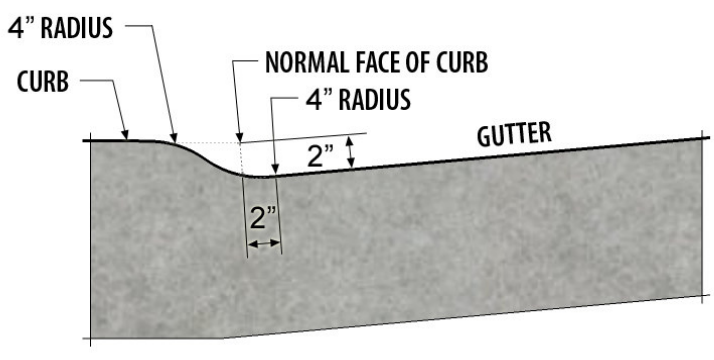
Date: 4/27/06

Std Dwg No:
SD-12B





Concrete Driveway – Residential Entrance
NTS



Lowered Curb Detail
NTS

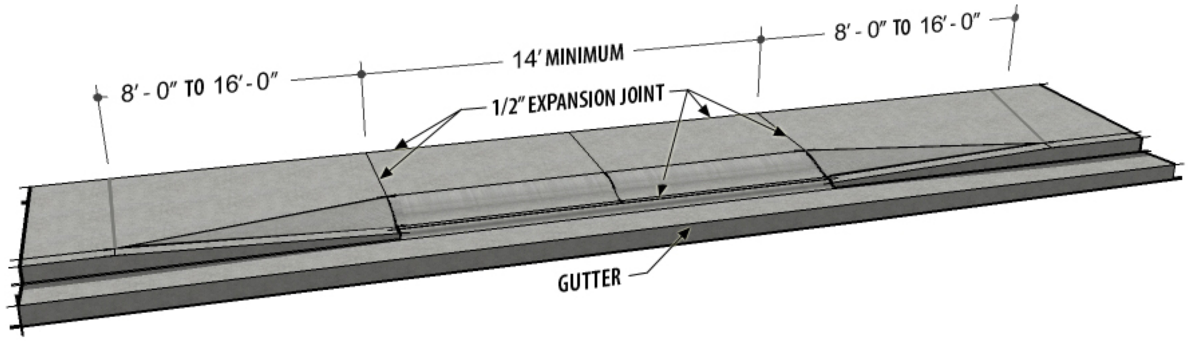
Notes:

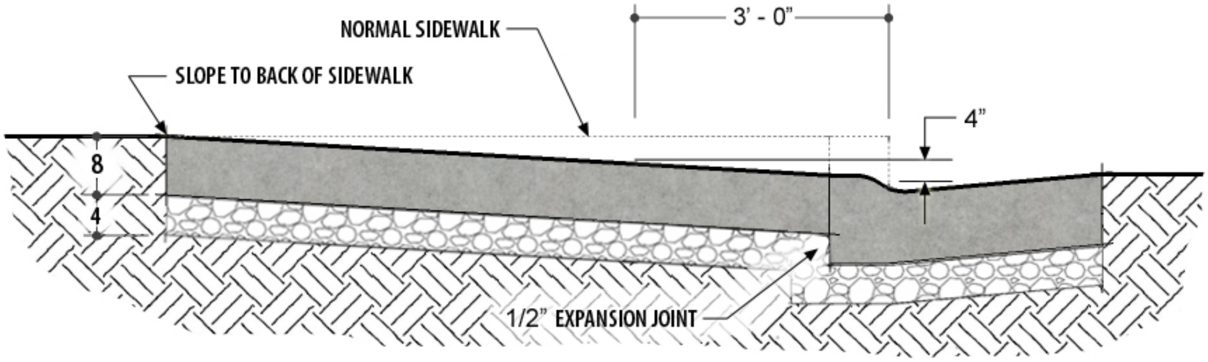
Concrete Drive Ramp Residential Entrance

City of Franklin
Engineering Department

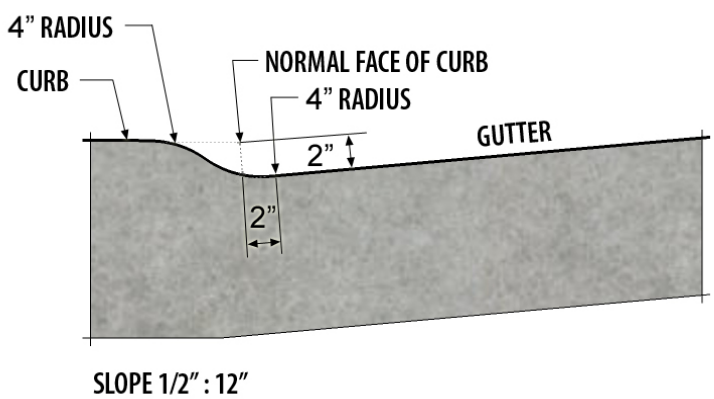
Date: 7/03/07

Std Dwg No:
SD-14A





Concrete Driveway – Commercial Entrance
NTS



Lowered Curb Detail
NTS

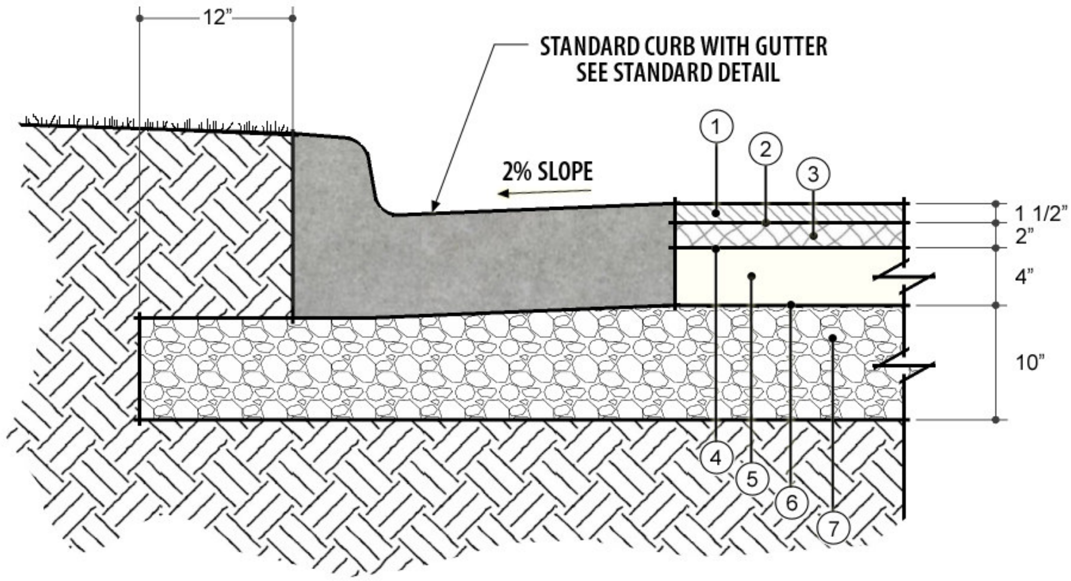
Notes:

Concrete Drive Ramp
Commercial Entrance

City of Franklin
Engineering Department

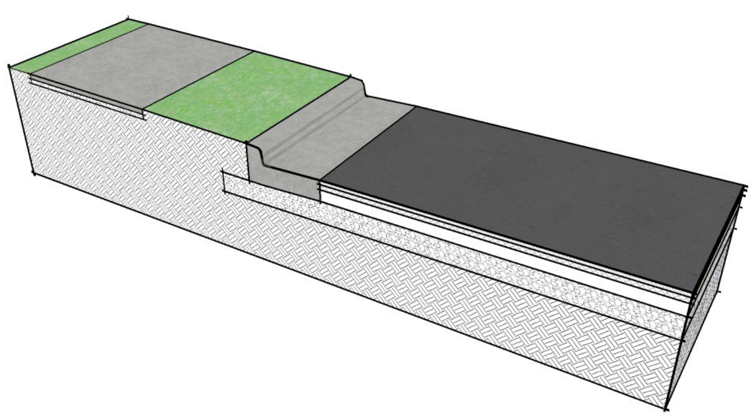
Date: 2/22/06

Std Dwg No:
SD-14B



Pavement Courses
NTS

1) 1 ½" Asphaltic Concrete Surface (Grading "E")
2) Tack Coat (RS-2)
3) 2" Asphaltic Concrete Base (Grading "B" Modified)
4) Tack Coat (RS-2)
5) 4" Asphaltic Concrete Base (Grading "A")
6) Prime Coat (AE-P)
7) 10" Stone Base (Grading D Pug Mill Mix)



Isometric View
NTS

Notes:

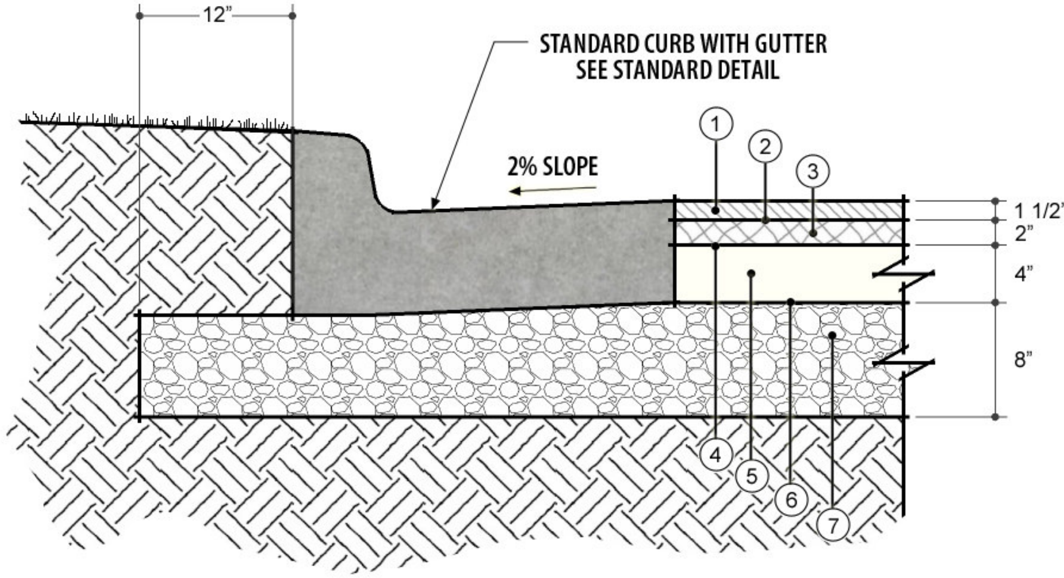
1) Maximum Sideslope Whether in Cut or Fill is to be 3:1.
2) Asphalt Thicknesses are Minimums. Thicknesses to be Determined by Geotechnical Design.

Arterial Pavement Section

City of Franklin
Engineering Department

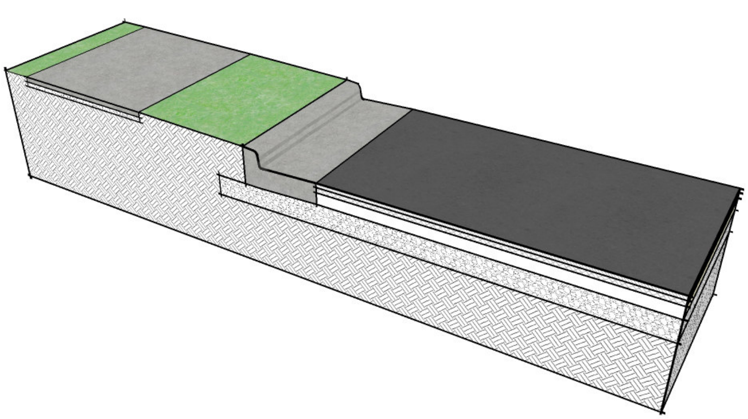
Date: 2/22/06

Std Dwg No:
SD-16



Pavement Courses
NTS

1) 1 ½" Asphaltic Concrete Surface (Grading "E")
2) Tack Coat (RS-2)
3) 2" Asphaltic Concrete Base (Grading "B" Modified)
4) Tack Coat (RS-2)
5) 4" Asphaltic Concrete Base (Grading "A")
6) Prime Coat (AE-P)
7) 8" Stone Base (Grading D Pug Mill Mix)



Isometric View
NTS

Notes:

1) Maximum Sideslope Whether in Cut or Fill is to be 3:1.
2) Sidewalks Not Required in Industrial Areas.
3) Asphalt Thicknesses are Minimums. Thicknesses to be Determined by Geotechnical Design.
4) Alleys Included

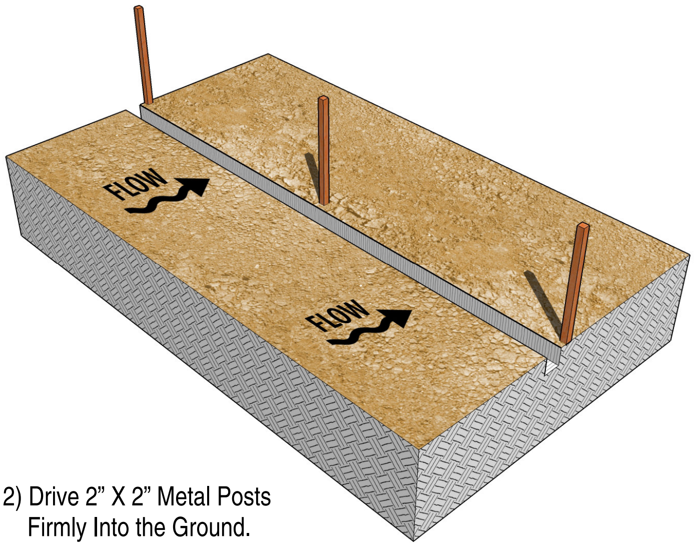
Local Commercial / Industrial Pavement Section

City of Franklin
Engineering Department

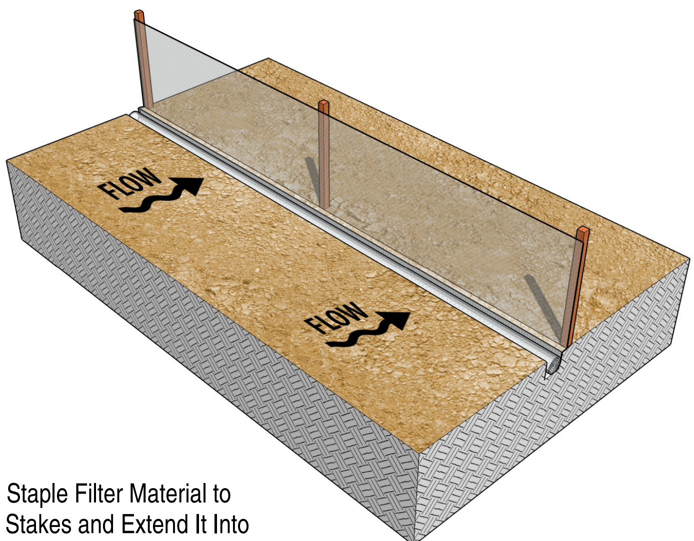
Date: 2/22/06

Std Dwg No:
SD-19

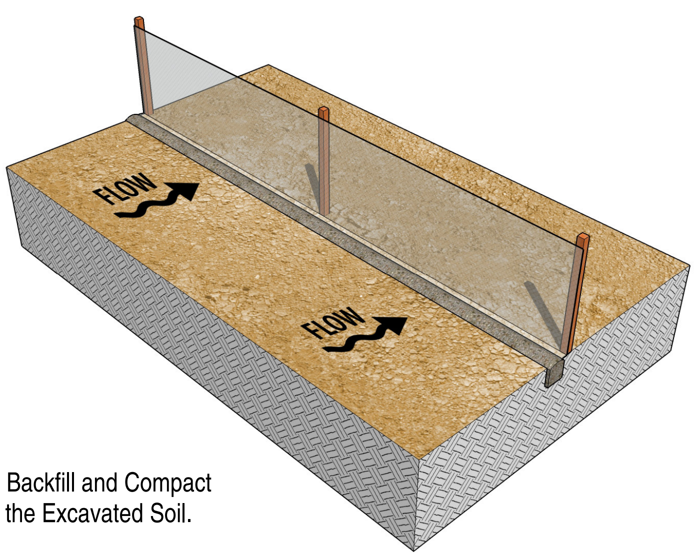
1) Excavate 6” X 6” Trench.



2) Drive 2” X 2” Metal Posts
Firmly Into the Ground.



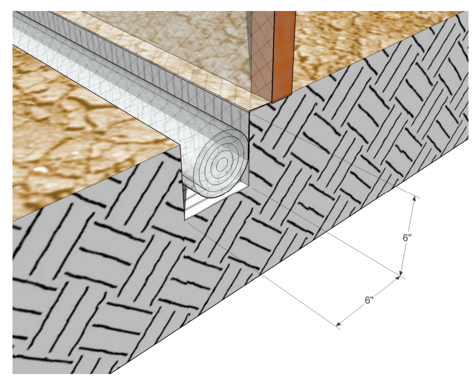
3) Staple Filter Material to
Stakes and Extend It Into
the Trench.



4) Backfill and Compact
the Excavated Soil.

Isometric View
NTS

Detail View
NTS



Notes:

1) For Use On Small Projects
(1 Acre or Less).

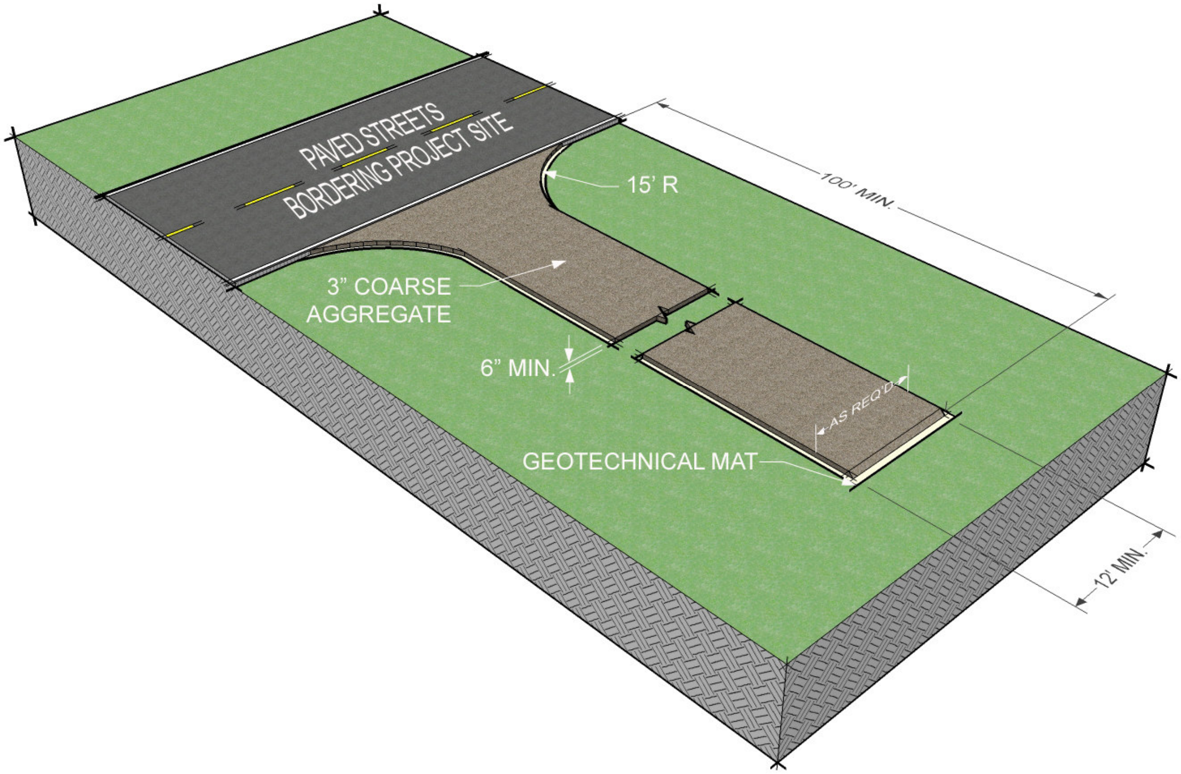
2) Verify That the Toe of the Fabric Is
Buried a Minimum of 6”.

3) The Contractor Shall Make Daily
Inspections and Repair Any and All
Silt Fence Failures.

Siltation Control Fence w/ Backing

City of Franklin
Engineering Department

Date: 4/27/06	Std Dwg No: SD-21



Isometric View
NTS

Notes:

1) When Roadside Ditches Are Encountered, An Adequately Sized Pipe Shall Be Installed.

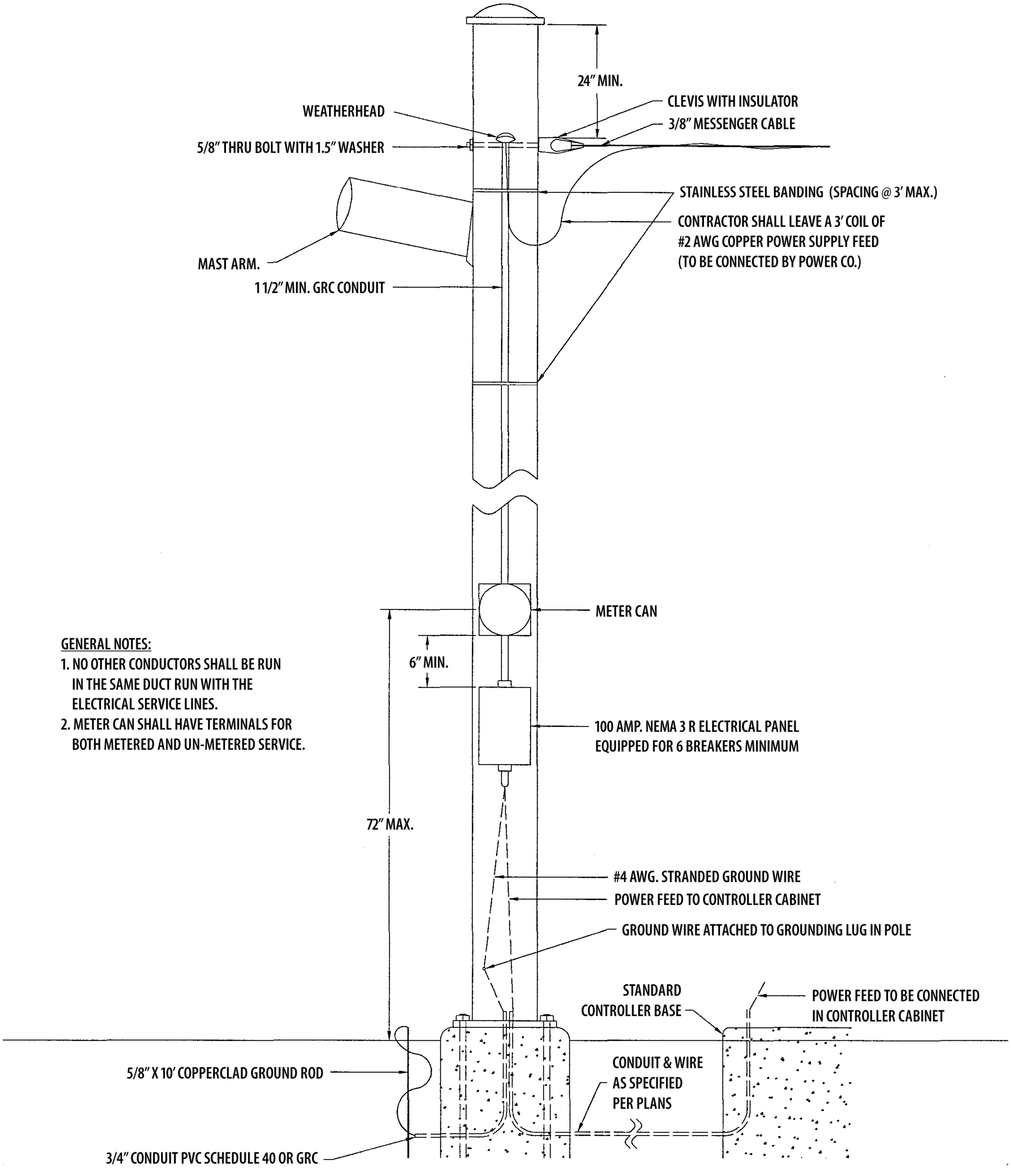
2) A Geotechnical Mat Shall Be Placed on the Subgrade Prior to the Installation of the Course Aggregate.

Construction Access

City of Franklin
Engineering Department

Date: 4/27/06

Std Dwg No:
SD-24



GENERAL NOTES:
1. NO OTHER CONDUCTORS SHALL BE RUN IN THE SAME DUCT RUN WITH THE ELECTRICAL SERVICE LINES.
2. METER CAN SHALL HAVE TERMINALS FOR BOTH METERED AND UN-METERED SERVICE.

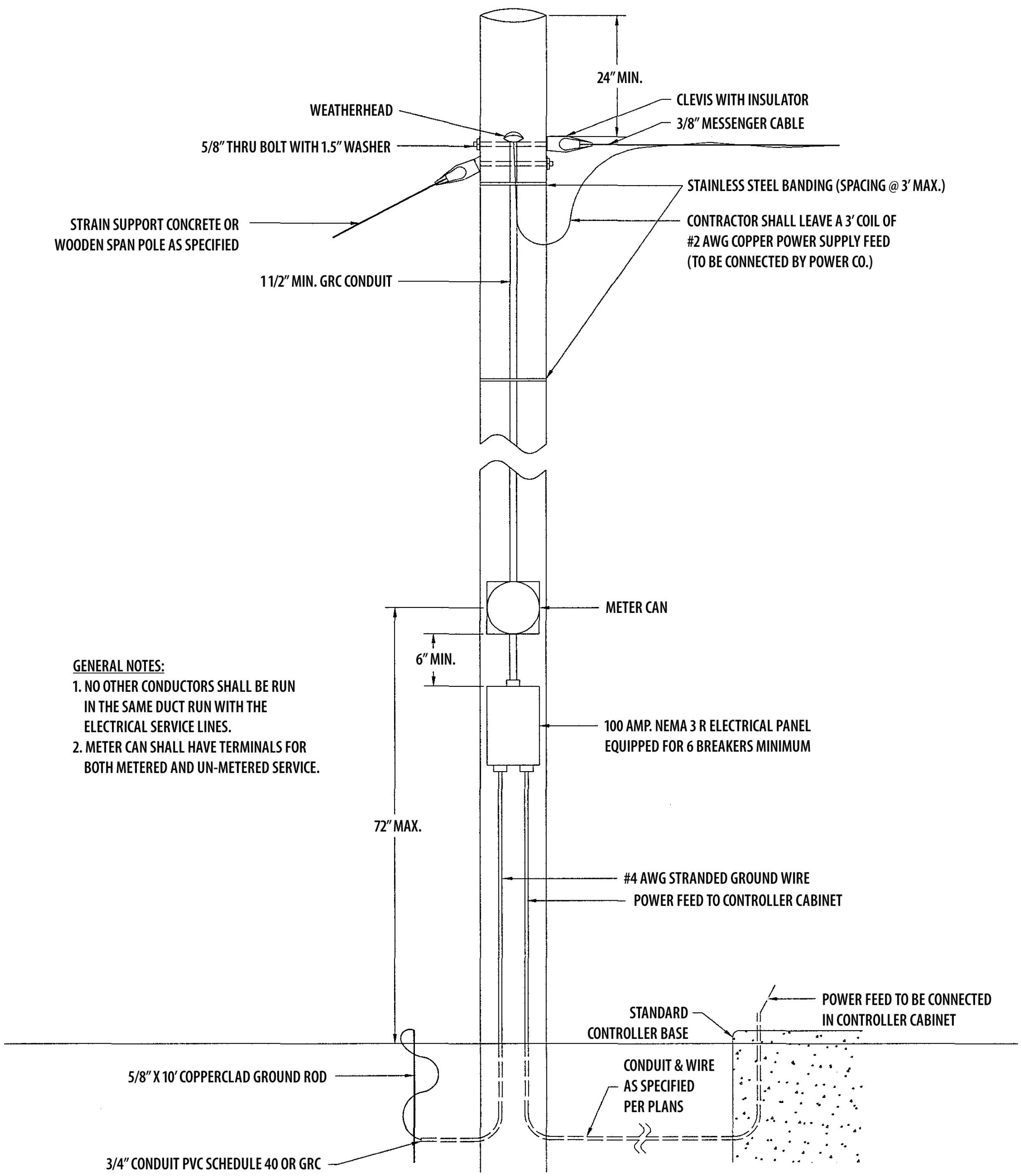
Side View
NTS

Electrical Service Details Traffic Signal Installation

City of Franklin
Engineering Department

Date: 4/27/06

Std Dwg No:
SD-26A



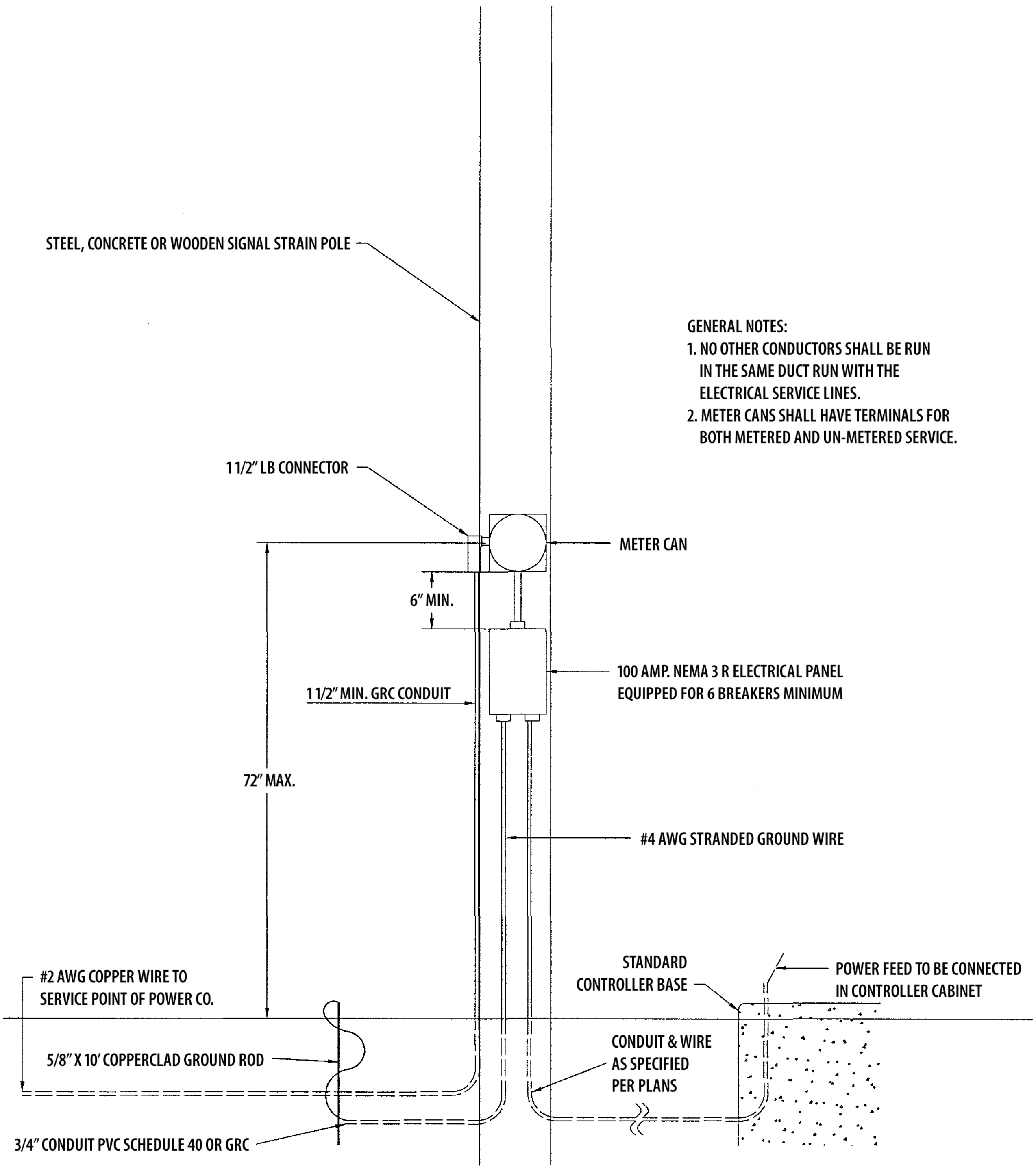
Side View
NTS

Electrical Service Details
Traffic Signal Installation

City of Franklin
Engineering Department

Date: 4/27/06

Std Dwg No:
SD-26B



GENERAL NOTES:
1. NO OTHER CONDUCTORS SHALL BE RUN IN THE SAME DUCT RUN WITH THE ELECTRICAL SERVICE LINES.
2. METER CANS SHALL HAVE TERMINALS FOR BOTH METERED AND UN-METERED SERVICE.

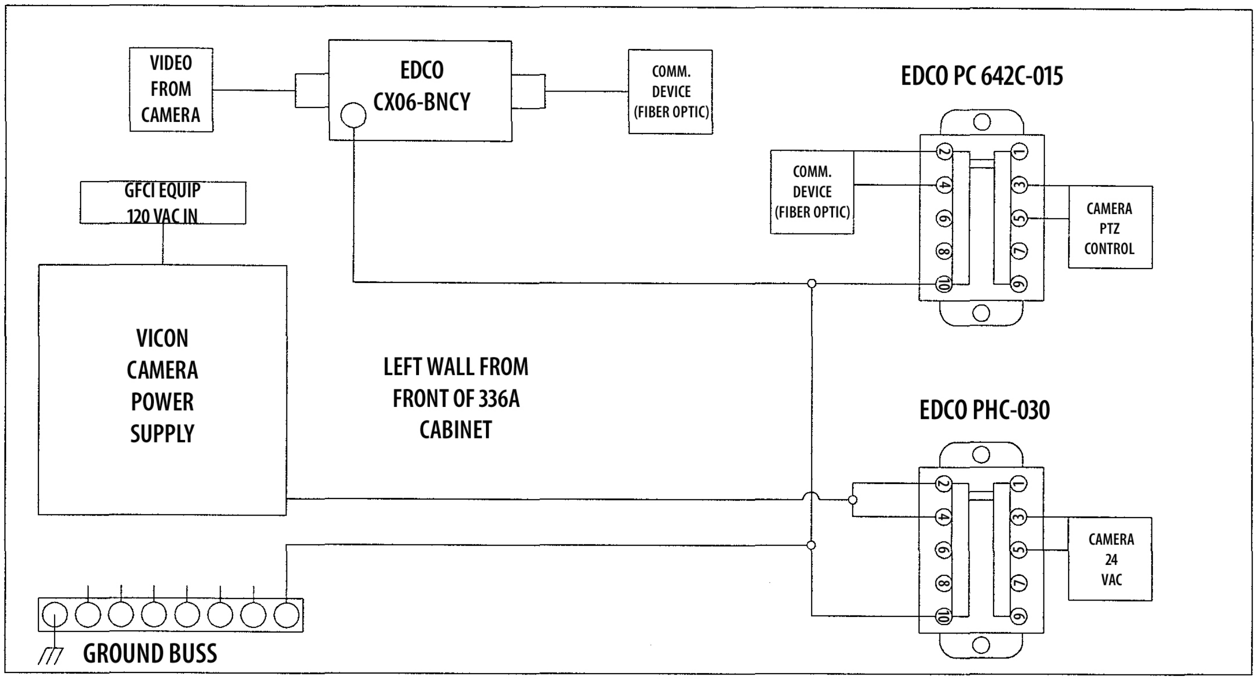
Side View
NTS

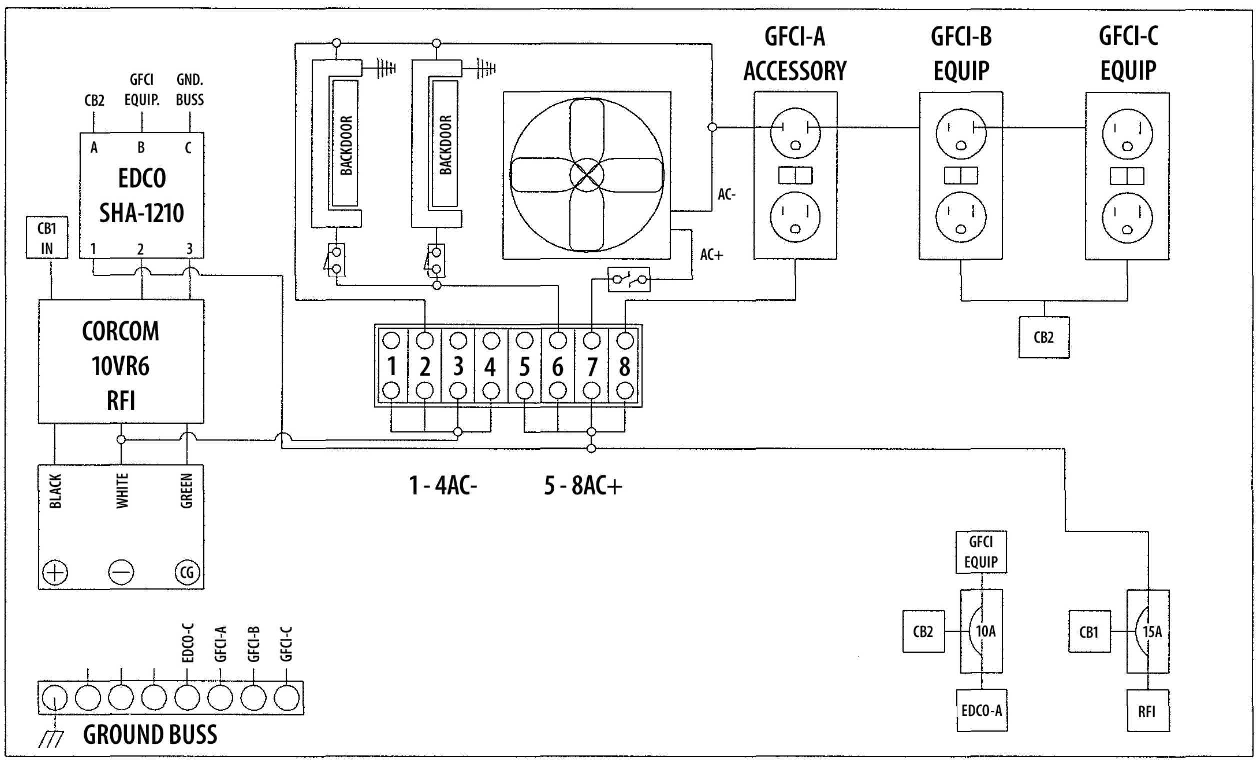
Electrical Service Details
Traffic Signal Installation

City of Franklin
Engineering Department

Date: 4/27/06

Std Dwg No:
SD-26C



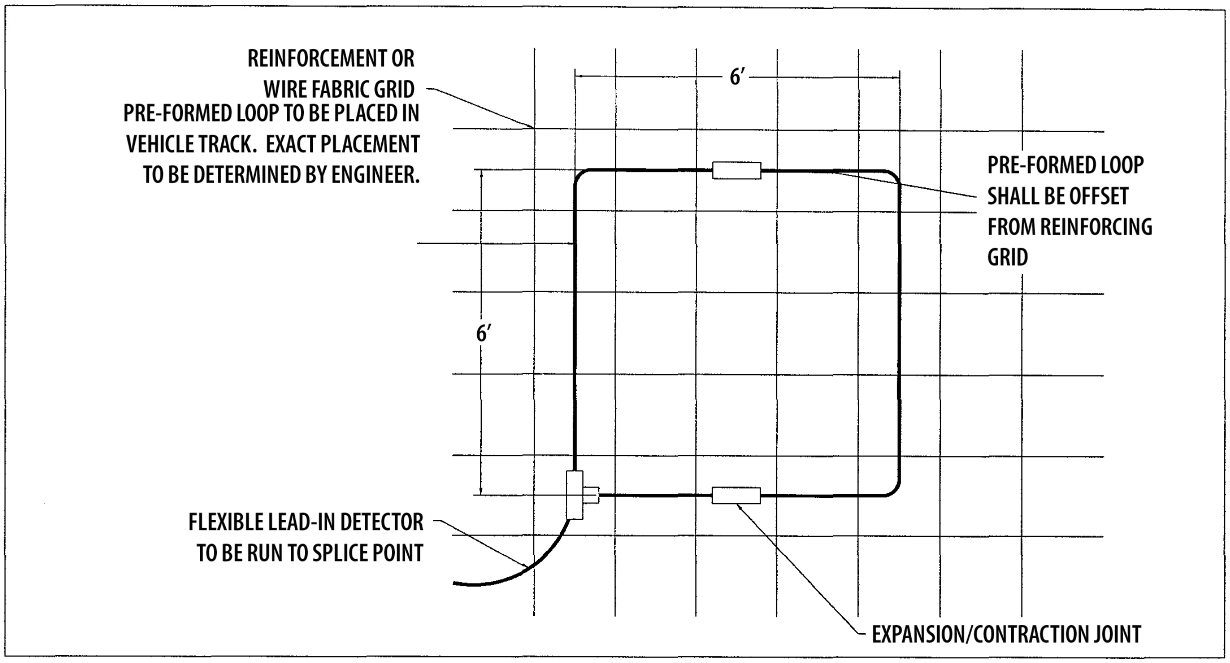


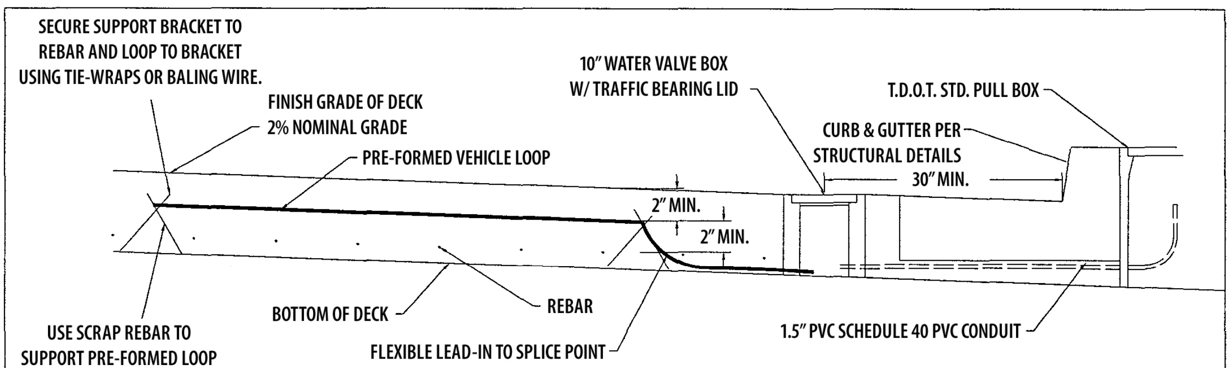
NTS

CCTV Surveillance Camera

City of Franklin
Engineering Department

Date: 4/27/06	Std Dwg No: SD-27



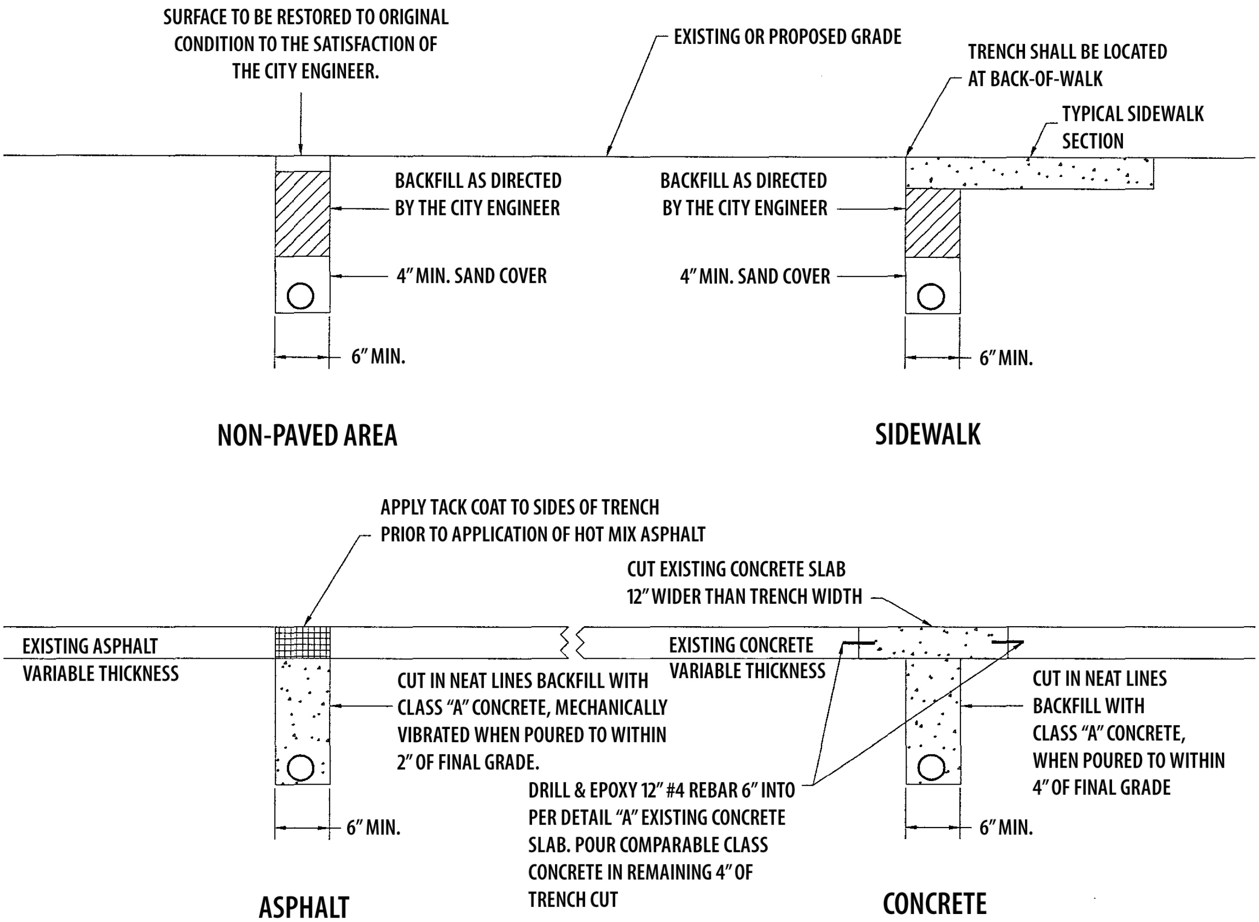


GENERAL NOTES:

1. REFER TO PLAN SET & SPECIFICATIONS FOR THE BRIDGE DECK OR CONCRETE PAVEMENT. LOOP PLACEMENT SHALL BE ADAPTED TO THE PLAN SET & THE ENGINEER SHALL MAKE FINAL DETERMINATION OF LOCATION & INSTALLATION DETAILS.
2. PRE-FORMED LOOPS SHALL BE EQUIVALENT TO THE "NEVERFAIL" MODEL C IN CONSTRUCTION. MANUFACTURER "CUT SHEETS" SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.

NTS

"Cast In Place" Pre-formed	
City of Franklin Engineering Department	
Date: 4/27/06	Std Dwg No: SD-28

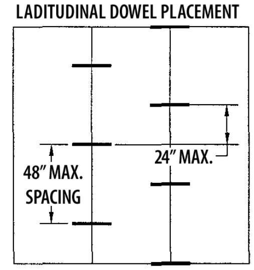


GENERAL NOTES:

1. TRENCH DEPTH SHALL BE 24" MINIMUM. SHOULD CONDITIONS NOT ALLOW FOR 24" MIN. DEPTH, THE CONDUIT SHALL BE CONCRETE (CLASS "A") ENCASED IN ALL APPLICATIONS.
2. SCHEDULE 80 P.V.C. CONDUIT SHALL BE USED IN ALL APPLICATIONS AND SHALL USE "LONG SWEEP" RADIUS BENDS.
3. SAWCUT SIDEWALK AT EXISTING JOINTS AND REPLACE ENTIRE SECTION TO MATCH EXISTING MATERIAL. WHEN NEW SIDEWALK IS BEING CONSTRUCTED, CONDUIT, PULL BOXES AND POLES ARE TO BE INSTALLED PRIOR TO SIDEWALK POUR AND SHALL BE LEVELED TO FINAL GRADE.
4. TYPE 2 WARNING TAPE SHALL BE INSTALLED IN ALL TRENCHES AT 12" BELOW FINISH GRADE.

DETAIL "A"

LADITUDINAL DOWEL PLACEMENT



NTS

Traffic Signal Trenching Details

City of Franklin
Engineering Department

Date: 4/27/06

Std Dwg No:
SD-29